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SCREENING HUMAN POPULATIONS FOR ABNORMAL RADIOSENSITIVITY

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SCREENING HUMAN POPULATIONS FOR ABNORMAL RADIOSENSITIVITY

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Abstract

A relatively rapid and inexpensive in vitro "growback" assay was developed that uses the irradiated versus the unirradiated re-growth responses of lymphoblastoid cell lines developed from individual donors as an estimator of donor radioresponse. The purpose of this project was to furnish an estimate of the proportion of strains derived from various study populations that may be regarded as exhibiting abnormal radioresponse. The emphasis in this study was on hypersensitivity, because of the known radiation-hypersensitivity and cancer-proneness associated with the genetic disorder ataxia-telangiectasia. Using methods developed especially for survival analyses, the percentage of significantly hypersensitive responses was 5½ % in a donor population composed of ostensibly normal individuals.

We also examined lines derived from an unselected cancer patient population. These were not enriched, compared to the reference normal population, for hypersensitive responses. We thu. conclude that hypersensitivity in vitro is not associated with increased risk for spontaneous development of cancer. However, the failure to observe an association between hypersensitivity and spontaneous cancer does not preclude a correlation between such sensitivity and radiogenic cancer.

At the present stage, we would caution against the application of this assay or related in vitro tests to the situation of an individual, as opposed to a population. While we have clear indications that hypersensitivity in vitro is associated with abnormal radioresponse in vivo, this study has identified sources of variation that must be understood before attempts are made to unambiguously attribute a particular type of radioresponse to an individual.

Résumé

Le présent rapport fait état d'une épreuve de reprise de croissance in vitro relativement rapide et peu coûteuse dans laquelle la reprise de croissance de cellules lymphoblastoïdes irradiées et non irradiées (obtenues à partir de prélèvements chez des donneurs individuels) est utilisée pour estimer la réponse radio-induite du donneur. L'étude visait à évaluer la proportion de souches, provenant de diverses populations à l'étude, présentant une réponse radio-induite qui pourrait être considérée comme anormale. Dans cette épreuve, l'accent était mis sur l'hypersensibilité en raison des phénomènes bien connus de radio-hypersensibilité et de prédisposition au cancer associés à l'ataxie-télangiecstasie qui est d'origine génétique. À l'aide de méthodes mises au point spécialement

pour les analyses de taux de survie, on a établi que le pourcentage de réactions d'hypersensibilité était d'environ 5,5 pour 100 dans une population de donneurs composée de personnes apparemment normales.

On a également examiné des souches provenant d'une population non sélectionnée de cancéreux. Par comparaison à la population normale de référence, ces souches n'avaient pas été enrichies dans le but d'obtenir des réponses d'hypersensibilité. On en conclut donc que l'hypersensibilité in vitro n'est pas liée à un risque accru d'apparition spontanée de cas de cancer. Cependant, le fait de ne pas observer de lien entre l'hypersensibilité et l'apparition spontanée de cancer ne veut pas dire qu'il n'existe aucune corrélation entre ce type de sensibilité et le cancer provoqué par les rayonnements.

Dans l'état actuel des connaissances, nous déconseillons donc l'application de cette épreuve ou de toute autre épreuve in vitro similaire à une personne plutôt qu'à une population. Bien qu'il existe des indications très nettes que l'hypersensibilité in vitro soit associée à une réponse radio-induite in vivo anormale, la présente étude a permis de déterminer certains facteurs de variation que l'on devra d'abord comprendre avant de tenter d'attribuer sans équivoque une réponse radio-induite particulière à une personne.

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1. INTRODUCTION

While the majority of human malignant neoplasms can be causally related to environmental agents (1,2), there is increasing recognition of the role played by predisposing host factors, such as genetic variations in response to carcinogen exposure. These latter are evidenced by the human genetic repertoire of loci where alteration can lead to significant increase in cancer risk: some 200 single gene traits that have neoplasia as either a feature or a complication have been identified, and for at least sixteen of these a clear inborn susceptibility to environmental carcinogens is recognized (3). Epidemiological studies also provide support for the idea of "susceptibility" in terms of genetically determined variations in response: in a study of some 2000 consecutively presented cancer probands, ~6% showed features consonant with known cancer-prone disorders and an additional ~18% showed familial susceptibility (using as criterion the existence of two or more first-degree family members with cancer at the same site; ref. 4).

For some of these human genetic syndromes associated with excess incidence of cancer, various in vitro assays have shown an association between these conditions and abnormal sensitivity of patient-derived cell lines to the cytotoxic action of particular carcinogens. Such abnormality is considered to be the result of defective ability to properly repair DNA lesions induced by the carcinogenic agent, viz. "Competent repair protects against carcinogens" (5) and "Patients with DNA repair deficiencies are more susceptible to carcinogens and more likely to develop cancer" (4). The implication in this hypothesis is that 'susceptible' persons may be at greater-than-expected risk of radiogenic cancer on occupational exposure; that is, in such persons it may be as if a higher dose had been received. While no solid evidence exists that this is the case, a prudent awareness of such a possibility is becoming part of radiation-protection thinking. Should there exist 'susceptible' (at increased risk) subgroups, the average degree of protection implied by regulations aimed at adequate radiation protection will not be met for all persons. The 1980 U.S. National Academy of Science Committee on the Biological Effects of Ionizing Radiation (6) notes the "....increasing recognition that there are human genotypes that confer both increased susceptibility or resistance [our emphasis added] to DNA damage and increased cancer risk after exposure to carcinogenic agents, including ionizing radiation", and also that "....if population subsets can be identified as being at substantially greater risk of radiation carcinogenesis, their risk will require separate estimation." In the 1988 UNSCEAR report (7), in the section on genetic constitution as one of the host factors that modify risk (paras. 442-450), it is stated that "Given the genetic variability that exists between individuals within a group and between groups, it is reasonable to presume that the risk of cancer may vary among individuals of the same sex, age and apparent life-styles when exposed to the same amount of ionizing radiation", and that "Data relevant to these issues are sparse, but those

that are available suggest there may be a small but non-trivial fraction of the human population that is prone to develop cancer and, as a consequence, may be much more liable to develop radiation-related cancers. This may mean that the average dose-response pattern is a relatively poor indicator of individual risk. It may be too low for those individuals especially predisposed, and too high for those individuals who are not at special risk. However, to improve the estimation of risk, one must be able to identify the susceptible individuals, which is not practicable at present".

To ascertain whether there may be a significant portion of the population-at-large that is abnormally sensitive to ionizing radiation, we developed an in vitro method for assaying radiosensitivity, employing cultured lymphoblastoid cell lines (LCL) developed from ostensibly normal, individual, volunteer, human donors. As the "growback assay" was relatively rapid and inexpensive, it allowed us to measure the in vitro radioresponses of a comparatively large number of donors. As well, we assayed the in vitro radioresponses of a similar number of LCL strains from cancer patient donors; by comparing their responses with those exhibited by the collection from clinically normal donors, we could investigate whether any type of abnormality was related to the "spontaneous" appearance of cancer. This report describes our findings.

2. METHODS AND APPROACH

The publications in Appendix C detail the development of individual lymphoblastoid cell strains from ostensibly normal donors and from cancer patients, the γ-irradiation conditions, and the "Growback" Assay (GBA). Each will be discussed briefly here.

The "ostensibly normal" strains (CR strains) were developed from small blood samples obtained anonymously from volunteer, atomic radiation worker (ARW) donors at Chalk River. The AECL Committee that considers and passes on experimentation involving human subjects approved our procedures and its purposes. The cancer patient strains (CP strains) were obtained largely from the Ottawa Regional Cancer Clinic (ORCC), Ontario Cancer Treatment and Research Foundation (OCTRF), through the kind offices and keen interest of Dr. C.E. Danjoux, Chief of Radiation Oncology (Ottawa Civic and Ottawa General Hospitals). These blood samples were supplied by volunteer cancer patient donors, and the protocols involved were approved by the hospitals' ethics committees.

The CR strains were assayed blind, and were coded by a representative of the AECB. Only after we had supplied the data from the GBA were the codes supplied to us.

Two ^{60}Co γ-irradiation protocols were employed. "Acute exposure" employed a dose of 1.67 Gy delivered at a dose-rate of ~2 $Gy \cdot min^{-1}$ in a Gamma-Cell 200. "Chronic exposure" was protracted, at ~0.003 $Gy \cdot min^{-1}$, and a total dose of 4 Gy was employed.

Measuring the radiation response of LCL by the GBA basically involved obtaining the unirradiated (control) and irradiated re-growth curves, using a Coulter Counter to enumerate apparently intact cells per unit volume. A "growback ratio" (GBR), the slope of the exponential portion of the growback curve for the irradiated population as a fraction of that for the unirradiated (control) population of that strain, is used as the radioresponse estimator. Using the ratio of the slopes serves to normalize for differences in the intrinsic growth rates of different LCL strains.

Our composite and individual strain results were analysed using statistical methods originally developed for use with in vitro cell survival assays (8).

In related work, we compared various methods of LCL strain establishment (one method involved stimulation by the mitogen phytohemagglutanin [PHA]; the other employed an immunosuppressive drug, cyclosporin A, which was a kind gift of Sandoz, Montreal). While the CP donor population had, in general, LCL strains established by each method, the CR population strain development employed largely the PHA approach. As well, strains were established from a number of donors at different times. This latter work indicated that, for some donors at least (perhaps 10%), appreciable swings in GBR may occur. As the objectives of this project were to represent the in vitro radioresponse of populations of LCL strain donors, to determine the proportion that may be abnormally radiosensitive, and to furnish (if demonstrable) an estimate for the degree of risk for 'spontaneous' development of cancer that may be associated with such a phenotype, we elected the approach that would address directly these questions; we utilize and report here all the results using one method (PHA) of strain establishment and, where a given donor had more than one LCL strain developed, only the first one established was incorporated into the population.

3. RESULTS AND DISCUSSION

Appendix A contains various tabulations of the statistical analyses performed on the various populations of LCL strains. The database summaries for these populations are supplied in Appendix B (Tables B-I through B-VIII; corresponding radioresponse distributions depicted in Figs. B-1 through B-8).

The semi-weighted study population values and statistical analyses according to Tarone et al. (8) are contained in Tables A-I through A-III (Appendix A). Some discussion of the rationale for the groupings employed is in order.

The cancer patient population has been divided into two groups: CP1 (CP strain numbers ≤106) and CP2 (CP strain numbers ≥107). CP1 represents the strains developed in the initial part of the study. They were to represent unselected patients, but a number appear to have been 'existing' patients who had already received treatment. Moreover, their blood samples were shipped to CRNL by courier; this often took 2 days or more, which likely accounted for a ~50% success rate for strain establishment. Starting in late November 1988, we travelled to Ottawa 2-3 times weekly to collect blood samples from freshly presented, unselected cancer patients; the samples had usually been taken that morning. These CP2 samples, which represented every new (first visit to ORCC) patient who volunteered, were transported by automobile to CRNL and LCL strain establishment was initiated on arrival by a team who worked into the evening. Our success rate for strain established on these samples was ~93%, which equalled what we reached on fresh blood samples from normal donors.

The temporal plots for GBR of the entire CP population (Figs. A-5 and A-6) furnish evidence for a 'discontinuity' between these two sub-groups: the CP1 population seems more likely to contain strains with relatively low GBR's. We had performed about half of the GBR's on the CP strains ignorant of this distinction, and when we drew this shift to the attention of ORCC oncologists, we learned that what we now distinguish as the CP1 group was "not entirely unselected" in that the physicians made an effort to ensure the inclusion, when they re-visited the clinic, of cancer patient donors who had, when subjected to conventional radiotherapy for tumour management, exhibited clinically some degree of adverse radioreaction. Indeed, the growback ratios for cell lines derived from 3 patients whose treatment was limited by their acute reaction to radiotherapy, are clustered at, or near, the bottom of the Growback Ratio range.

Published work communicating preliminary stages of this work, when only 30-50 cancer patient LCL strains had been assayed in vitro, therefore largely reflected the CP1 donor population. By using the response of A-T strains as a guide to hypersensitivity, we reported that hypersensitive radioresponses in vitro were more likely in a cancer patient compared to normal donor population, and therefore that increased probability of developing cancer seemed to be associated with hypersensitivity. We now know, by examination of a truly unselected CP donor population (CP2), that this early inference is incorrect.

Within the CP2 population itself, or within the CR (normal) population (Figs. A-3 and A-4; Table A-VI), the temporal plots are consistent with there

being no systematic change in our strain establishment or assay procedures over this period (ca. 1½ years).

The plots of GBR versus age for the CR donor population show a pattern of slight increase in radiosensitivity (decrease in GBR) with increasing donor age (Figs. A-1 and A-2; Table A-V). This effect, although small, is significant ($p << 0.001$; t-test). No attempt has been made to correct the data for this effect.

A comparison of the male versus female CR population radioresponses indicates a lower semi-weighted GBR for the female population in both the acute and chronic γ-exposure tests (Table A-IV). This difference is only--and just barely ($p = 0.049$)--significant in the chronic test. In our analyses, we have pooled the male and female data for both sets of dose-rate radiosensitivity measurements.

Thus, although our CR population is a reasonable representation of what may be expected for the general population, it is not exact because of this effect of age and likely of sex. For the comparisons we make, however, and the conclusions we draw, it suffices.

We therefore have six populations for comparison. The average variance for each group is broken into experimental variance and genetic variance (Table A-I) according to Tarone et al. (8). The group semi-weighted GBR means (or mean in the case of CP2, acute exposure), variance estimators, and lower and upper 95% confidence intervals (8) for these groups are given in Table A-II.

The results of the significance tests for pair-wise comparisons of these study populations are summarized in Table A-III. The CP1 population is significantly different from the CP2 response in both the acute and chronic ($p << 0.001$ and ≈ 0.01, respectively) radiosensitivity tests; CP1 is more radiosensitive (Table A-II) in both cases. CP1 includes some strains from donors who exhibited untoward clinical response to radiotherapy; CP2 is unselected. This shows that increased radiosensitivity in vitro, as reflected by clinicians' judgement of adverse radioreaction, is correlated with increased radiosensitivity by this in vitro assay. Although the CP1 population included some existing cancer patients who had been through a course of therapy already, while the CP2 group had not commenced treatment, it is unlikely that the greater hypersensitivity in CP1 is occasioned by prior exposure to ionizing radiation, since any selection by this treatment modality would be expected to be in the opposite direction.

CP1 is significantly different (more radiosensitive) from the CR (normal) population in the acute but not in the chronic γ-exposure test (Tables A-II and

A-III). This suggests that response to acutely-delivered ionizing radiation may be the better predictor of quickly-evident adverse radioreaction in patients scheduled for radiotherapy.

The question of whether increased risk of spontaneous development of cancer is associated with abnormal radiosensitivity is addressed by the comparison of the CR (normal) versus CP2 populations. CP2 was not enriched for hypersensitive responses; in fact, this population contained a notably lower proportion of such responses than did the normal population. We thus conclude that hypersensitivity in vitro is not associated with increased risk for spontaneous development of cancer. The failure to observe an association between hypersensitivity and spontaneous cancer development, however, does not preclude a correlation between such sensitivity and radiogenic cancer.

When the CR and CP2 populations are compared statistically, the direction of difference, in fact, is towards greater radioresistance in CP2 compared to CR (normal) (Tables A-II and A-III). This may arise because of the notably lower proportion of highly hypersensitive responses in the CP2 group.

Increased radioresistance has been seen as a laboratory hallmark in at least two familial cancer-prone conditions (9).

The percentages of abnormal radioresponses ($p < 0.05$) for these populations can be determined from the information supplied in Appendix B and are summarized, ± standard deviation of the estimate, in Table I. The reference population for attribution of significant abnormality (8) to individual LCL strains is, in all cases, the CR (normal) population tested at the corresponding dose-rate. For the acute-γ test, the normal population has 13.3±2.5% abnormal responses; for the chronic-γ testing method, the value is 15.6±2.7%.

We are unable to calculate a putative risk factor, for the likelihood of developing spontaneous cancer, that may be associated with significant increased radioresistance seen in the group comparison of the CP2 compared to normal population, because there is no excess proportion of individual abnormal responses in the former compared to the latter.

A breakdown with respect to the direction of the abnormal radiosensitivity for the CR (normal) strains is given in Table II. About 5½% of strains tested are found to be significantly hypersensitive; 8-10% are significantly radioresistant.

Table I. Proportion of abnormal radioresponses in the various study populations of LCL strains tested in the growback assay[a]

Population	Test Mode	No. Abnormal/ Total	Proportion of Abnormal Responses ± 1 SD[b]
CR normal	Acute	24/180	13.3% ± 2.5%
CR normal	Chronic	28/180	15.55% ± 2.7%
CP1	Acute	3/51	5.9% ± 3.3%
CP1	Chronic	4/51	7.8% ± 3.8%
CP2	Acute	6/147	4.1% ± 1.6%
CP2	Chronic	6/147	4.1% ± 1.6%
AT	Acute	6/9	66.7% ± 15.7%
AT	Chronic	6/9	66.7% ± 15.7%

(a) For the normal population, a strain is deemed to be abnormal if its mean GBR falls outside the 95% confidence interval defined by the mean GBR and standard deviation of the total normal population. For strains in the other populations the decision is made based on the probability (on a 2-sided T-test, variances not assumed equal) that each strain's mean GBR falls within the 95% confidence interval around the mean GBR of the total normal population. Strains for which $p<0.05$ are classed as abnormal.

(b) The standard deviation σ of the estimated percentage of abnormal responses is

$$\sigma = \sqrt{\frac{\frac{x}{n}\left[1-\frac{x}{n}\right]}{n}} \times 100\%$$

where x = number of strains deemed abnormal and n = number of observations.

Table II. Breakdown of abnormal radioresponses (see Table I) into "sensitive" and "resistant", with respect to the mean, for the 'ostensibly normal' and the A-T donor populations

Population [sample size]	γ-test	no. with p<0.05	no. sensitive [%]	no. resistant [%]
CR normal [180]	acute	24	10 [5.6%]	14 [7.78%]
	chronic	28	10 [5.6%]	18 [10.0%]
AT [9]	acute	6	6 [66.7%]	0
	chronic	6	6 [66.7%]	0

Neither the acute nor chronic exposure tests detected more than 2/3 of the nine A-T strains as abnormal (Table I). This is because the doses elected for radiosensitivity testing were deliberately not chosen with a view to detecting AT-level hypersensitivity. For example, Fig. 1 (text) shows the GBR versus chronic γ-ray dose response for two radionormal and three A-T strains. If the A-T are compared to normal strains at equal effect (e.g., at a GBR of 0.4 or 0.5), the A-T strains are in the order of five times more radiosensitive. The GBR dose-response curves for radiosensitive A-T lines exhibit a "hockey-stick" response at doses ≥1Gy, and the proportion of the cell population that contributes to this non-exponential region is different in different A-T lines, although all three exhibited the same apparent radiosensitivity at 1Gy (Fig. 1). The statistical approach of Tarone et al. (8) assumes responses are on the exponential part of the dose-response curves; this seems not to be the case for A-T strains, and quite possibly not for the majority of hypersensitive CR strains, and results in decreased statistical rigour. A similar argument of diminished rigour would seem applicable to radioresistant responses, since they likely show an extended shoulder region.

Significant abnormality is referenced to the distribution for CR strains. As an illustration of the degree to which the test may be detecting (or missing) hypersensitivity, we would mention that even for A-T strains, only 4/9 registered in both tests as significantly hypersensitive (of the 6/9 'detected' in each test, 4 were common; Tables B-7 and B-8). This probably relates to the dose chosen for

Table III. Tabulation of abnormal ($p<0.05$) radioresponses, divided into "sensitive" and "resistant", according to whether they registered as normal by both tests, by the acute-γ test only, or by the chronic-γ test only, for the population of ostensibly normal donor LCL strains and for the A-T strain population.

Population [number]	Sensitive			Total [%] sensitive by at least one test	Resistant			Total [%] resistant by at least one test	Total no. of strains [%] that are abnormal by at least one test
	Both tests	Acute only	Chronic only		Both tests	Acute only	Chronic only		
CR normal [180]	6	5	4	15 [8.3%]	6	8	12	26 [14.4%]	41 [22.8%]
AT [9]	4	2	2	8 [88.9%]	0	0	0	0 [0%]	8 [88.9%]

testing being too high for efficient detection of this level of hypersensitivity (Fig. 1). The situation can be improved if the criterion for hypersensitivity is taken as "significant difference" ($p<0.05$) in either test; then 8/9 A-T strains (89%) register as hypersensitive (Table III, text). In view of this and the considerations raised in the previous paragraph, we consider that a more probable estimate of abnormal radioresponses in the 'normal' population is obtained by applying the same criterion to the CR population. On this basis, nearly 23% of the strains from the normal population show abnormal radioresponse (Table III); 8.3% of strains are hypersensitive and 14.4% of strains are radioresistant.

These results are conveniently depicted in Figs. 2 through 4 for the population of ostensibly normal donors. Figure 2 is a plot of GBR obtained for the chronic test versus the acute test for all 180 CR strains; Figs. 3 and 4, on the same scales, identify those strains for which $p<0.05$ in the acute and chronic tests, respectively.

4. SUGGESTIONS FOR FUTURE WORK

In at least some cases where donors were 'accessed' two or more times for LCL strain development and in vitro radiosensitivity testing, considerably different GBR were obtained. These differences seem greater than expected from the experimental variance. We need to understand the sources and nature of these variations in order to extend the results of the present project, which is essentially a population genetics approach, as unambiguously as possible to an inference about the donor.

The demonstration in this project of an appreciable range (some 5-fold, in the chronic test) of in vitro radioresponse, and of a significant proportion of strains with abnormal radiosensitivity, is an important input to future radiation protection considerations. Priority should be given to experimental approaches aimed at understanding whether or not such abnormality is associated with excess risk of radiogenic cancer specifically. The study of the CP2 population does not suffice to demonstrate there is no risk--it only serves to indicate that the relative risk is not exceedingly high. This is because ionizing radiation or "ionizing-like" DNA damage makes only a relatively small contribution to "spontaneous" cancer. What is needed is to assess radiosensitivity in a group of persons who have received relatively large exposures in the past, and compare those who have not developed cancer to those who have.

A comment about assay cost is in order. In the screening of just the CR and CP populations, 3065 radiosensitivity assays were performed. This works out to $228 per measurement, and includes strain establishment work.

In conclusion, the final words of the discussion summary report from the CEC/AECL Workshop on Methods for Determining Differential Radiosensitivity in Humans (U. of Sussex, Brighton, 1988 September 7-9) may be noted:

> "Finally, it is necessary to start to think of the implications which the measurement of individual radiation sensitivity might have for radiation protection philosophy. The existence of critical groups in the population has been taken into account for a long time now in radiation protection. Although the definition of these critical groups has been based predominantly on exposure pathways and age, it might be prudent also to take into account the occurrence of critical groups in the population on the basis of their increased radiation sensitivity."

5. ACKNOWLEDGEMENTS

The input, good guidance and scientific advice of the Review Panel (Drs. McBurney, Paterson and Raman), and of the AECB Scientific Advisors who have followed this project, are gratefully acknowledged.

The assistance of the staff at the ORCC, and most especially of Dr. C.E. Danjoux (Chief, Radiation Oncology) was invaluable. Dr. Danjoux's keen interest in in vitro radiosensitivity as a predictive indicator of adverse reaction and ultimate treatment outcome gave a sense of immediacy to this aspect of the study. Our data will be used in prospective studies at the ORCC and has led to related research there.

Some of our early cancer patient samples came from Drs. Dai and Corbett at the London Clinic, OCTRF, as arranged by Dr. T. Bichay.

Within AECL, the encouragement of: Dr. J.C.D. Milton, Vice-President of the Physics and Health Sciences PRC; Dr. A.M. Marko (Director of Health Sciences or Assistant to the V.P. for most of the project period); and Dr. D.K. Myers (Manager, Radiation Biology Branch, for a large portion of this project), is warmly acknowledged. To L. Morel--who provided valuable secretarial assistance--our thanks.

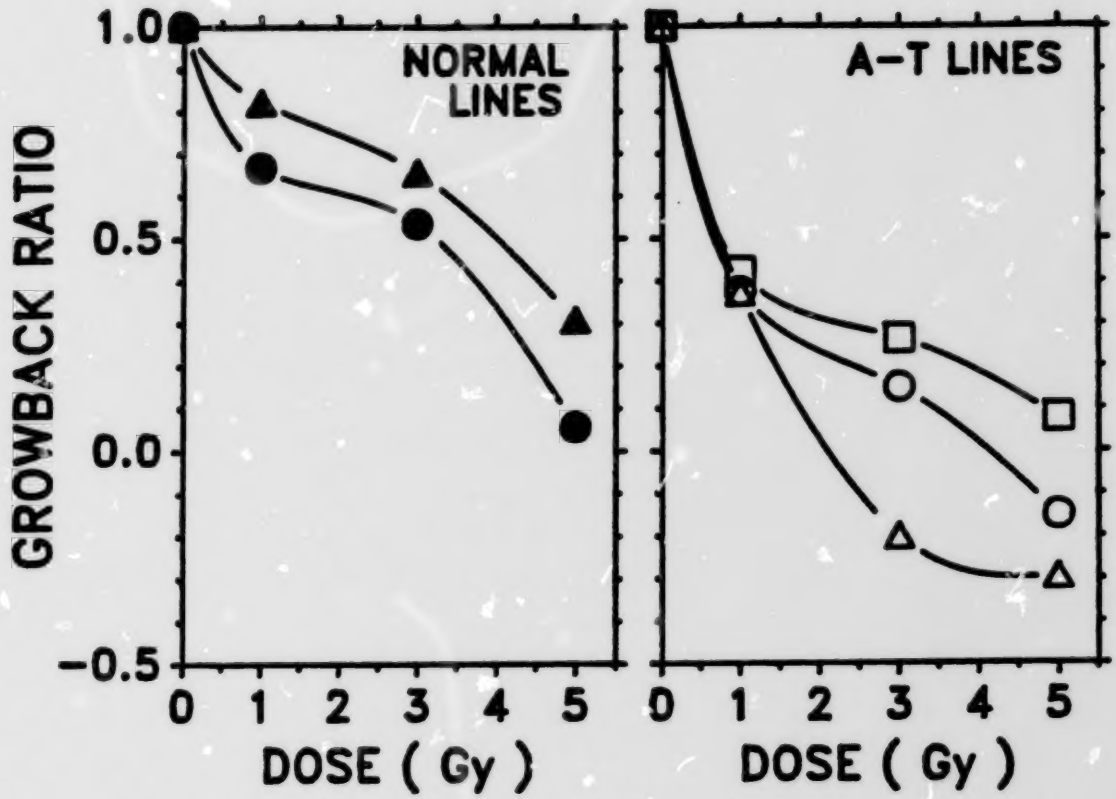

Fig. 1. Growback ratio as a function of chronic γ-ray exposure for 2 normal lines (o, GM1954; Δ, GM1990) and for 3 AT patient lines (□, GM0717; Δ, GM3189; o, GM8436).

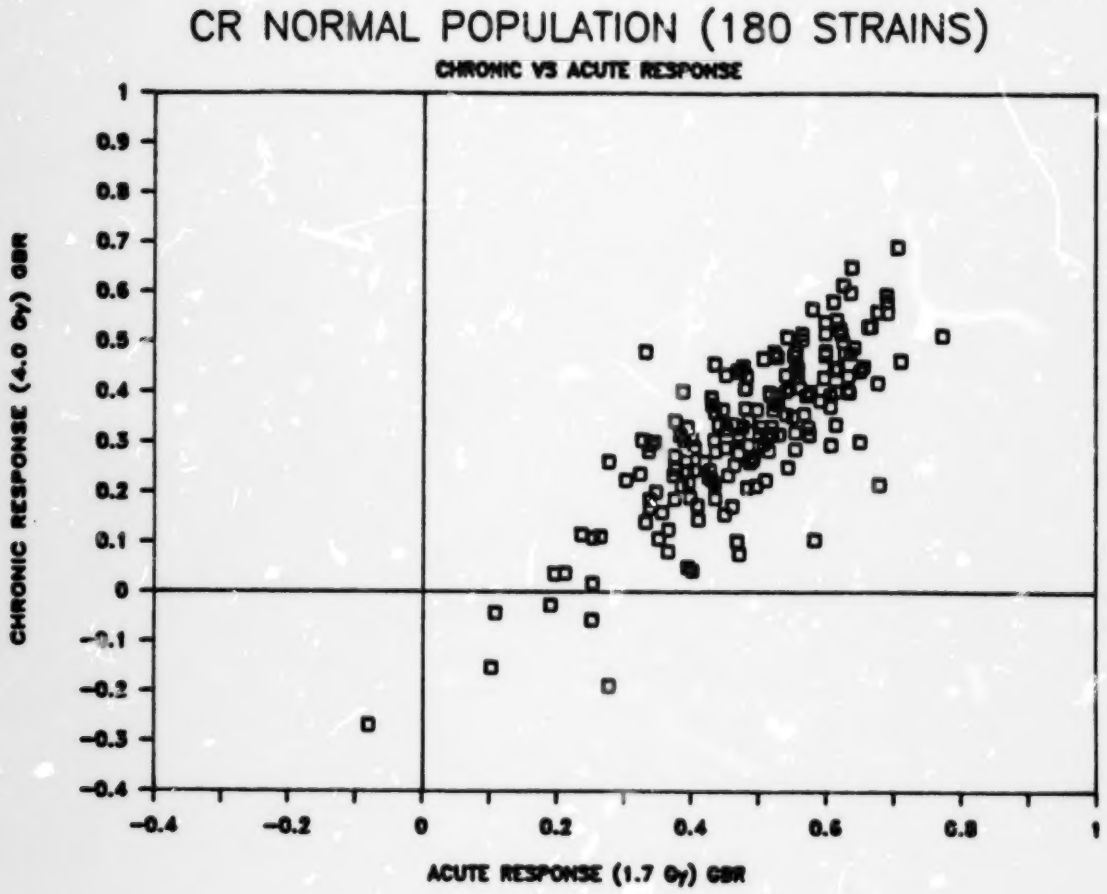

Fig. 2. Plot of the weighted means of the GBR (growback ratios) obtained in the chronic γ-exposure growback assay versus that obtained in the acute γ-exposure growback assay, for 180 lymphoblastoid cell lines derived from ostensibly normal (non-cancer) individual, volunteer donors.

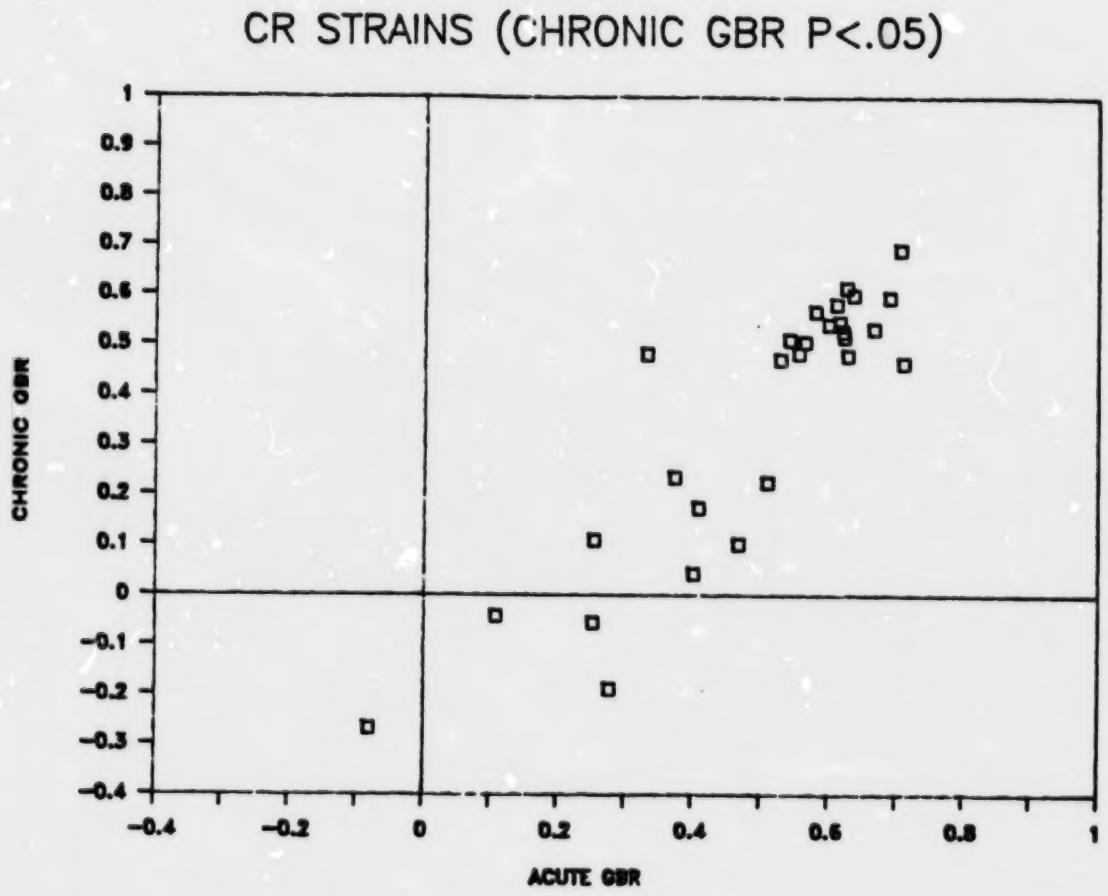

Fig. 3. "Chronic GBR" versus "acute GBR" for CR strains (i.e., from ostensibly normal donors) that were significantly different ($p<0.05$) from the 'composite normal' value in the chronic γ-exposure growback assay specifically. This includes some strains that are hypersensitive and some that are radioresistant.

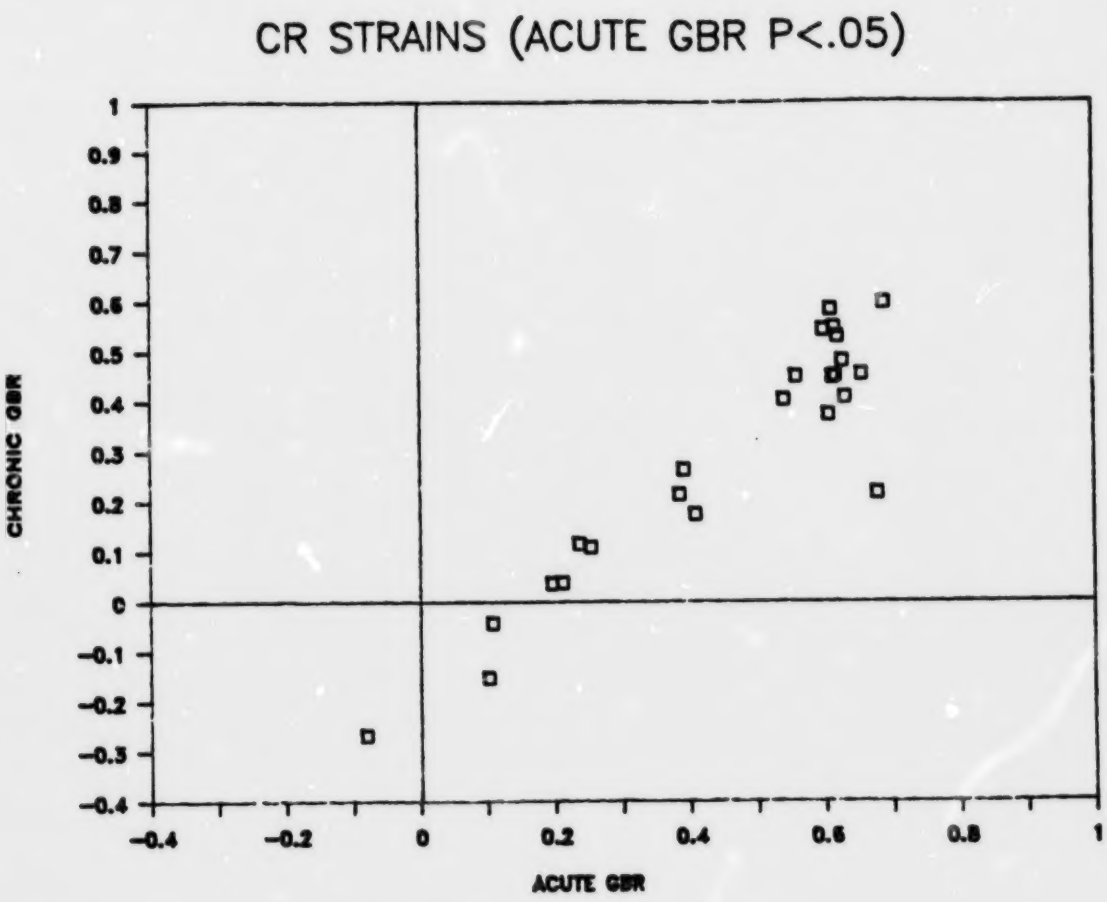

Fig. 4. "Chronic GBR" versus "acute GBR" for CR strains that were significantly different ($p<0.05$) from the 'composite normal' in the acute γ-exposure growback assay. By comparison with Fig. 2, the 12 strains that are abnormal by both tests (6 in the 'sensitive' cluster and 6 in the 'resistant' cluster) can be identified (cf. Table III).

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APPENDIX A

STATISTICAL ANALYSES

(A. Wills, Environmental Research Branch, CRNL)

The approach used is based on the article entitled "Statistical methods for in vitro cell survival assays: by Robert E. Tarone, Dominic A. Scudiero, and Jay H. Robbins, in Mutation Research 111 (1983), 79-96.

Summary Estimation for Groups of Cell Lines

Assume R unrelated cell lines

- parameter of interest is e
- estimate of e from the r^{th} cell line is $\hat{E}_r$
- estimate of variance of $\hat{E}_r$ is V_r
- average experimental variance: $\bar{V} = \sum_{r=1}^{R} \frac{V_r}{R}$
- if $V_E = \sum_{r=1}^{R} \left(\frac{\hat{E}_r - \bar{E}}{R-1} \right)^2$ where $\bar{E} = \sum_{r=1}^{R} \frac{\hat{E}_r}{R}$
- then $V_G = V_E - \bar{V}$ is the intrinsic variance among cell lines or the genetic variance.

TABLE A-I. Values of the average experimental variance ($\bar{V}$), the experimental variance (VE), and the intrinsic variance (VG) among cell lines or presumed genetic variance (VG) for the six population groups for which the group members' apparent radiosensitivity was studied in vitro by the growback assay using immortalized lymphoblastoid cell lines derived from these donors.

	Normal Acute	Normal Chronic	CP1 Acute	CP2 Acute	CP1 Chronic	CP2 Chronic
$\bar{V}$	0.004182	0.006243	0.014712	0.014774	0.017074	0.011313
V_E	0.016719	0.025358	0.015509	0.006207	0.039127	0.012321
V_G	0.012537	0.019115	0.000797	-0.008567	0.022052	0.001008

CONDITION 1:

- if $V_B/V_r > 3.0$ for all r then the group mean is estimated by $\bar{E}$ with variance estimator $V(\bar{E}) = V_B/R$

CONDITION 2:

- if $\bar{V} > V_B$ then the group mean is estimated by $\bar{E}$ with variance estimator $V(\bar{E}) = \bar{V}/R$

- for all data sets except CP1 acute exposure, neither condition 1 nor condition 2 is true so a semi-weighted mean is appropriate.

- for CP1, acute exposure, condition 2 is true so a semi-weighted mean is not appropriate.

- semi-weighted mean:

$$\bar{E}_{SW} = \sum_{r=1}^{R} \frac{U_r \hat{E}_r}{U} \qquad U_r = \frac{1}{V_G + V_r} \qquad U = \sum_{r=1}^{R} U_r$$

- the variance of $\bar{E}_{SW}$ is estimated by:

$V(\bar{E}_{SW}) = 1/U$

- approximate $(1-\alpha)$ 100% confidence intervals for the group mean is:

$$\bar{E}_{SW} \pm \sqrt{V(\bar{E}_{SW})}\ t^{\alpha}_{R-1}$$

TABLE A-II. SEMI-WEIGHTED MEAN OR MEAN, VARIANCE ESTIMATOR, AND 95% CONFIDENCE INTERVALS FOR THE SIX POPULATION GROUPS STUDIED BY THE IN VITRO "GROWBACK ASSAY"

	CR normal Acute	CR normal Chronic	Cancer Acute CP #≤106	Cancer Acute CP #≥107	Cancer Chronic CP #≤106	Cancer Chronic CP #≥107
Group mean	$\bar{E}_{SW}$ = 0.489473	$\bar{E}_{SW}$ = 0.33229	$\bar{E}_{SW}$ = 0.395231	$\bar{E}$ = 0.505764	$\bar{E}_{SW}$ = 0.299791	$\bar{E}_{SW}$ = 0.374657
Variance estimator	$V(\bar{E}_{SW}) = 8.70830 \times 10^{-5}$	$V(\bar{E}_{SW}) = 1.32627 \times 10^{-4}$	$V(\bar{E}_{SW}) = 1.35373 \times 10^{-4}$	$V(\bar{E}) = 1.00505 \times 10^{-5}$	$V(\bar{E}_{SW}) = 6.36622 \times 10^{-4}$	$V(\bar{E}_{SW}) = 4.01647 \times 10^{-5}$
R	180	180	51	147	51	147
Lover 95% C.I.	0.471255	0.309488	0.371845	0.499487	0.249076	0.362109
Upper 95% C.I.	0.508395	0.355092	0.418617	0.512041	0.350506	0.387205

Comparing Two Groups of Cell Lines

- let $\bar{E}_1$ be the summary mean for the first group of R_1 cell lines with estimated variance $V(\bar{E}_1)$
- let $\bar{E}_2$ be the summary mean for the second group of R_2 cell lines with estimated variance $V(\bar{E}_2)$
- then if there is no difference between the two groups with respect to the parameter e the statistic

$$T = \frac{\bar{E}_1 - \bar{E}_2}{\sqrt{V(\bar{E}_1)+V(\bar{E}_2)}}$$

will have an approximate t-distribution with f degrees of freedom where

$$f = \left\{ \frac{[V(\bar{E}_1)/(V(\bar{E}_1)+V(\bar{E}_2))]^2}{R_1-1} + \frac{[1 - V(\bar{E}_1)/(V(\bar{E}_1)+V(\bar{E}_2))]^2}{R_2-1} \right\}^{-1}$$

Table A-III. Pair-wise comparison of the radioresponse of various LCL strain groups[1].

Comparison between:	T	f	p[2]
CR normal donors: acute vs. chronic exposure test	10.61	341	<<0.001*
Acute exposure: CP1 vs. CP2	9.17	58	<<0.001*
Chronic exposure: CP1 vs. CP2	2.68	56	≈ 0.01*
Acute exposure: CR normal vs. CP1	6.33	122	<<0.001*
Acute exposure: CR normal vs. CP2	1.61	218	≈ 0.1
Chronic exposure: CR normal vs. CP1	1.17	72	≈ 0.2
Chronic exposure: CR normal vs. CP2	3.22	273	<<0.001*

(1) CP1 is the "possibly selected" cancer patient population group comprising CP strain numbers up to and including CP106. CP2 is the non-selected group of freshly-presenting patients with strain numbers of CP107 and above.

(2) * = significantly different using $p \leq 0.05$ as criterion.

Probability in File

- for each cell line in the file, a comparison has been made with the appropriate normal population to see if the parameter estimates are the same.

- if more than one experiment is done on a cell line the t statistic is

$$T_r = \frac{\bar{E}_1 - \hat{E}_r}{\sqrt{V(\bar{E}_1)+V_r}}$$

with degrees of freedom

$$f_r = \left\{ \frac{[V(\bar{E}_1)/(V(\bar{E}_1)+V_r)]^2}{R_1-1} + \frac{[V_r/(V(\bar{E}_r)+V_r)]^2}{n_r-1} \right\}^{-1}$$

- If only one experiment is done on a cell line the t statistic is

$$T_r = \frac{\bar{E} - \hat{E}_r}{\sqrt{V(\bar{E}_1)/R_1}}$$

with R_1-1 degrees of freedom.

Table A-IV. Statistical comparison of male versus female responses for the CR donors; methods as for Tables A-I and A-II.

Population and radiosensitivity test	n	$\bar{V}$	V_E	V_G	$\bar{E}_{SW}$	$V(\bar{E}_{SW})$	MALE versus FEMALE comparison		
							Mode	T f	P
Female, acute exposure	43	0.003064	0.014874	0.011811	0.470112	3.38627×10^{-4}	Acute	1.201 73	
Female, chronic exposure		0.004951	0.024527	0.019576	0.291597	5.52391×10^{-4}			0.22
Male, acute exposure	137	0.004533	0.017284	0.012751	0.495742	1.16939×10^{-4}	Chronic	2.06 70	≈0.05
Male, chronic exposure		0.006649	0.025124	0.018475	0.346862	1.70770×10^{-4}			(0.049)

Fig. A-1. Distribution of GBR (growback ratio) versus age (years) for CR strains (ostensibly normal donors) subjected to the acute γ-exposure (1.7 Gy) test.

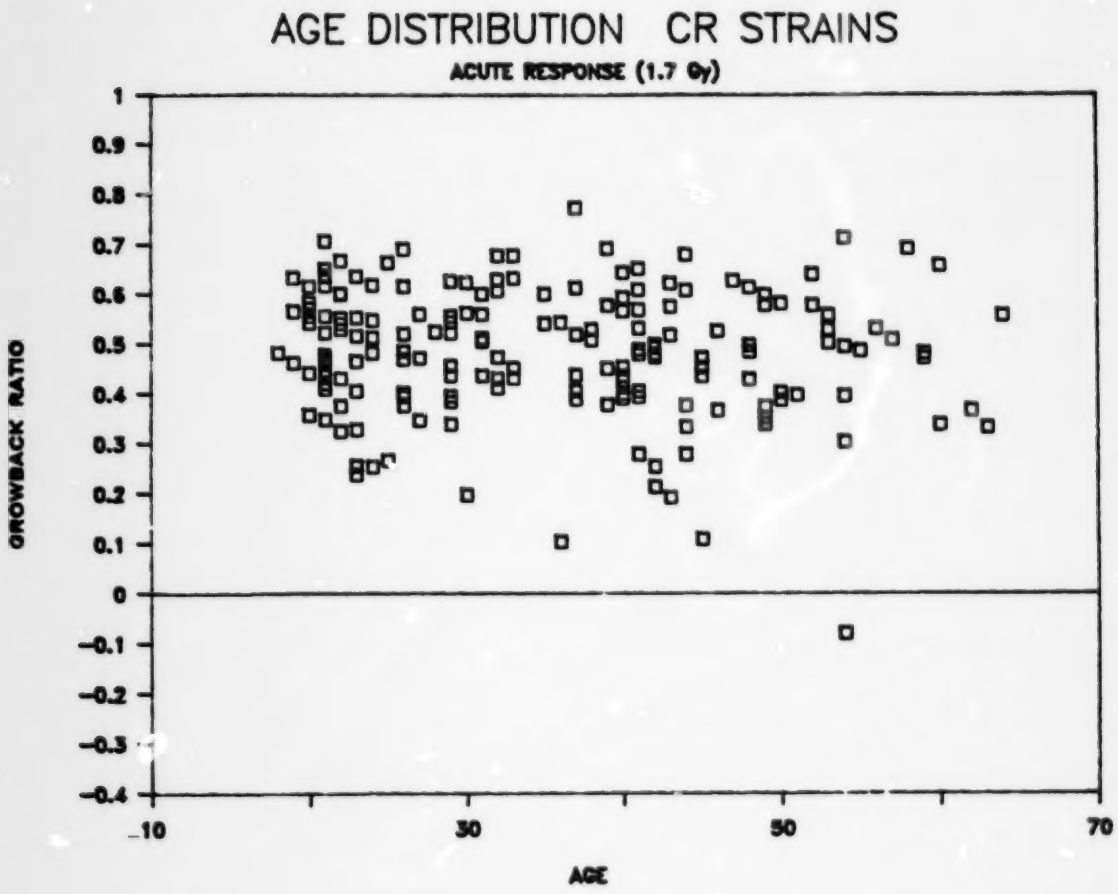


Fig. A-2. Distribution of GBR versus age (years) for CR strains tested by the chronic γ-irradiation protocol (4 Gy).

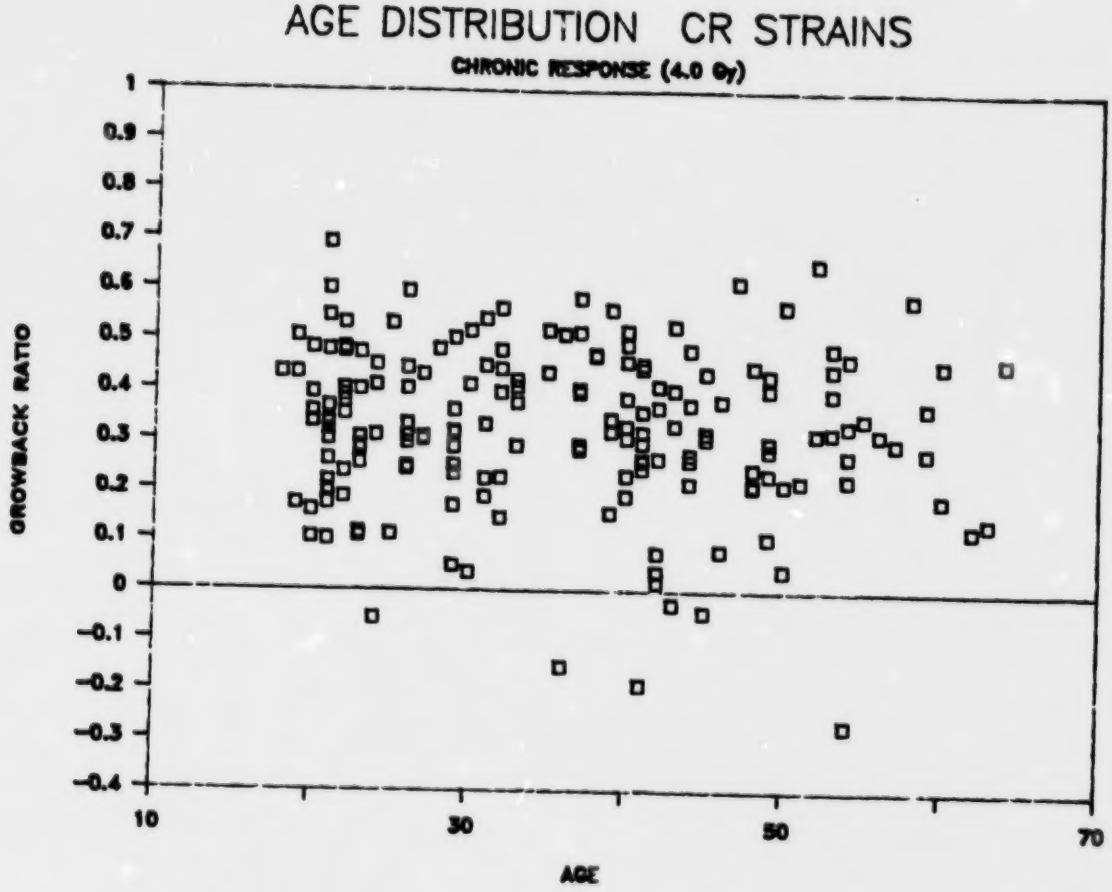


Table A-V. Linear regression of GBR versus age for the *in vitro* radiosensitivity testing of lymphoblastoid cell lines from ostensibly normal donors.

γ-Exposure Mode	Y-intercept (GBR) ± standard error	No. of observations [degrees of freedom]	X-coefficient (age, years) ± standard error
Acute	0.525683 ± 0.128921	180 [178]	- 0.00114 ± 0.000801
Chronic	0.369140 ± 0.159058	180 [178]	- 0.00117 ± 0.000988

Fig. A-3. Temporal plot for the acute γ *in vitro* radiosensitivity test (weighted GBR versus the order in which the strains were established) for the 180 CR strains from ostensibly normal donors.

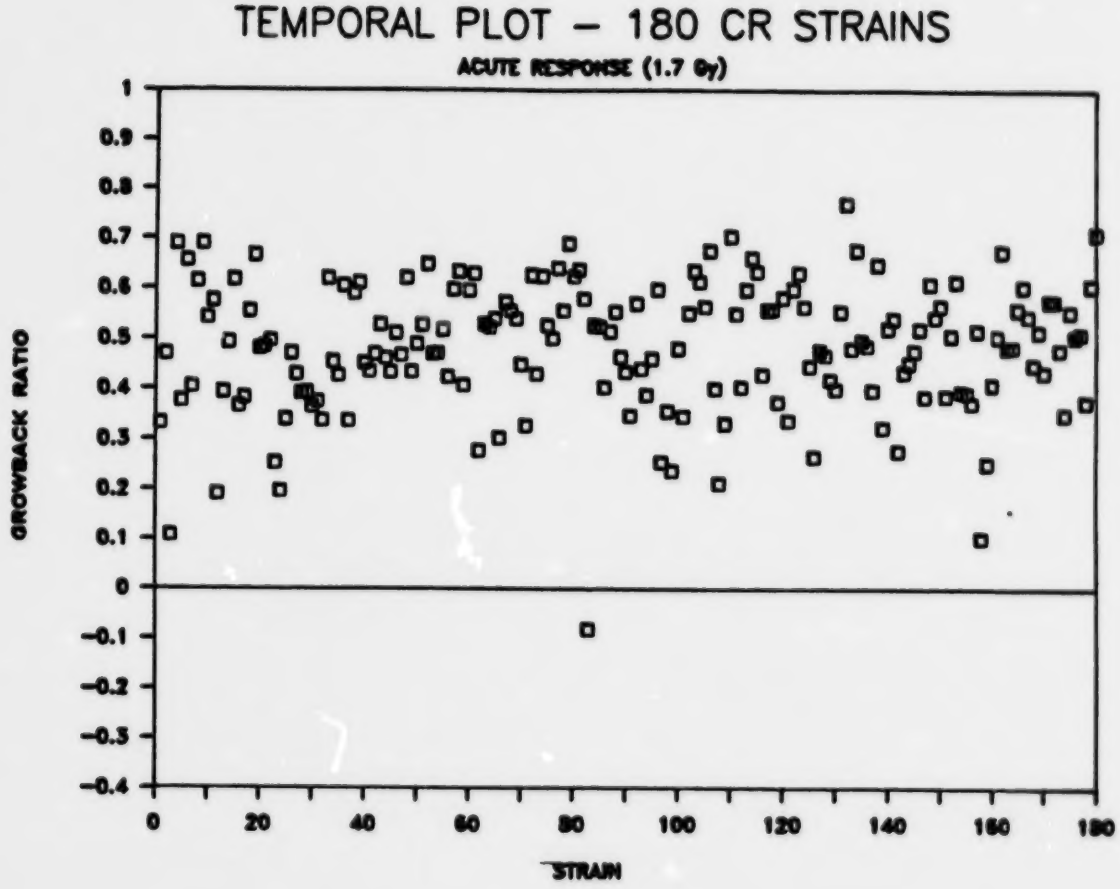


Fig. A-4. Temporal plot for the chronic-γ *in vitro* radiosensitivity test (veighted GBR versus the order in which the strains vere established) for the 180 CR strains from ostensibly normal donors.

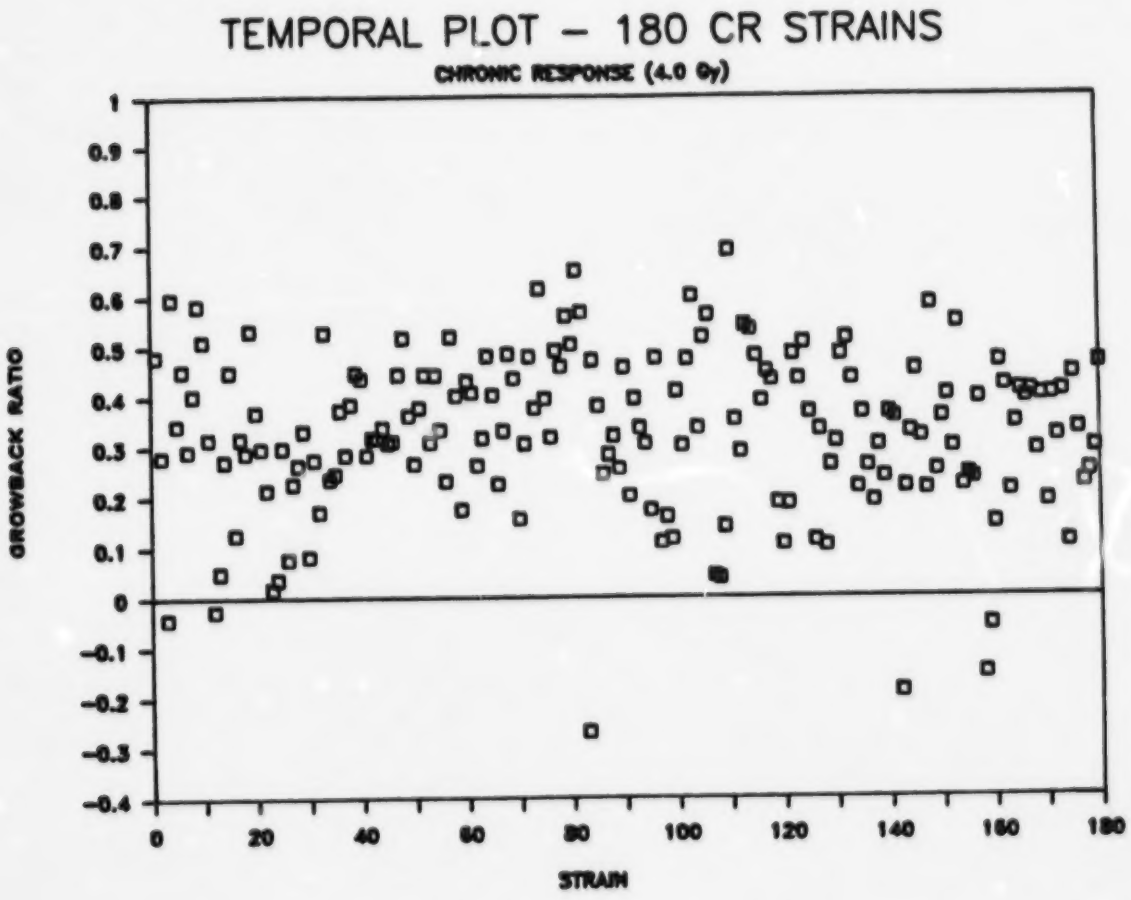


Table A-VI. Linear regression fit of GBR versus "temporal order" in which the LCL strains were established, for the *in vitro* radiosensitivity testing by the growback assay of lymphoblastoid cell lines established from ostensibly normal donors (CR strains).

γ Exposure	Y-intercept (GBR) ± standard error	No. of observations [degree of freedom]	X-coefficient ± standard error
Acute	0.469471 ± 0.129361	180 [178]	0.000169 ± 0.000185
Chronic	0.332082 ± 0.159665	180 [180]	- 0.00005 ± 0.000229

Fig. A-5 Temporal plot for the acute-γ *in vitro* radiosensitivity test (weighted GBR versus the order in which the strains were established) for 198 CP (cancer patient) LCL strains. The first 51 (CP strain numbers ≤106) constitute the CP1 population; the remainder (147 strains; CP strain numbers ≥107) are the CP2 (unselected) population. CP1 includes some donors who were promoted by oncologists for inclusion in our study because of some degree of clinical adverse radioreaction; we were not informed of this until after the strains had been assayed and the results made known to our clinical collaborators. The vertical line represents this division between the CP1 and CP2 populations.

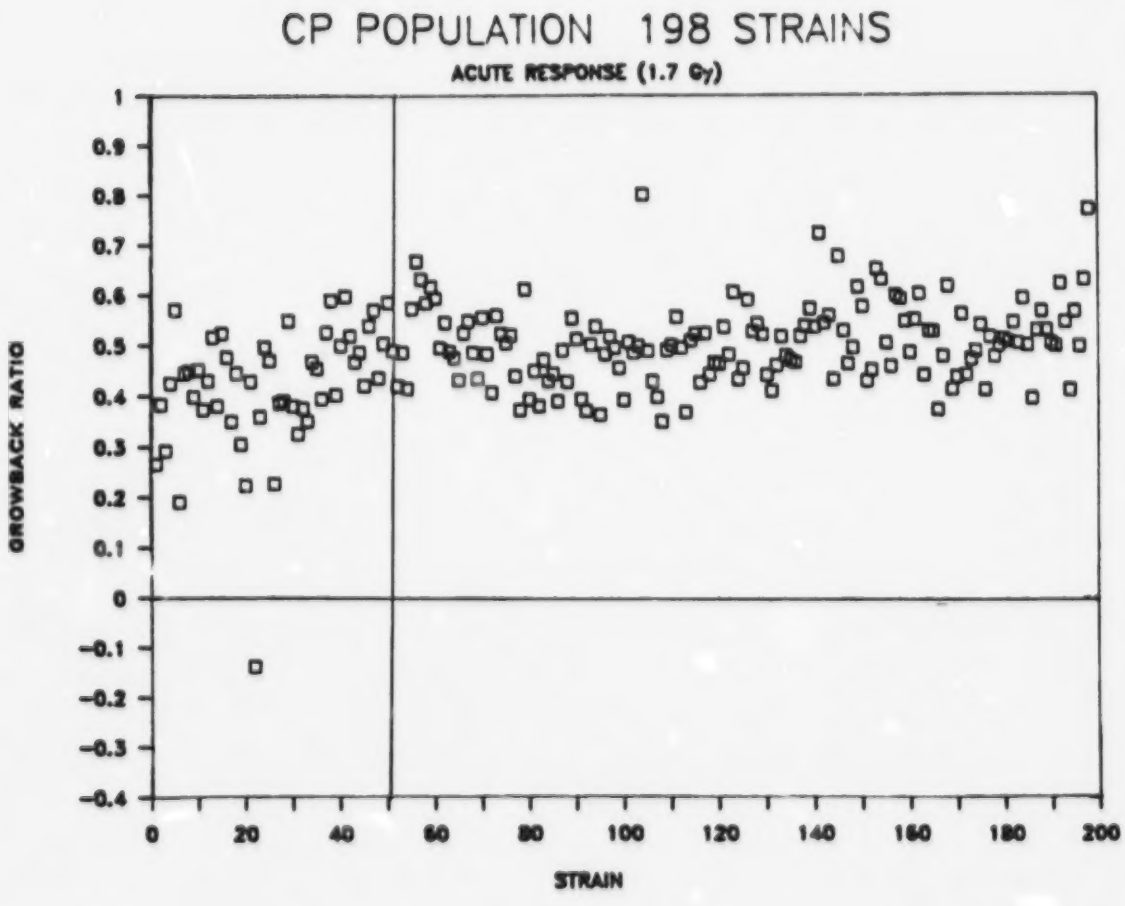
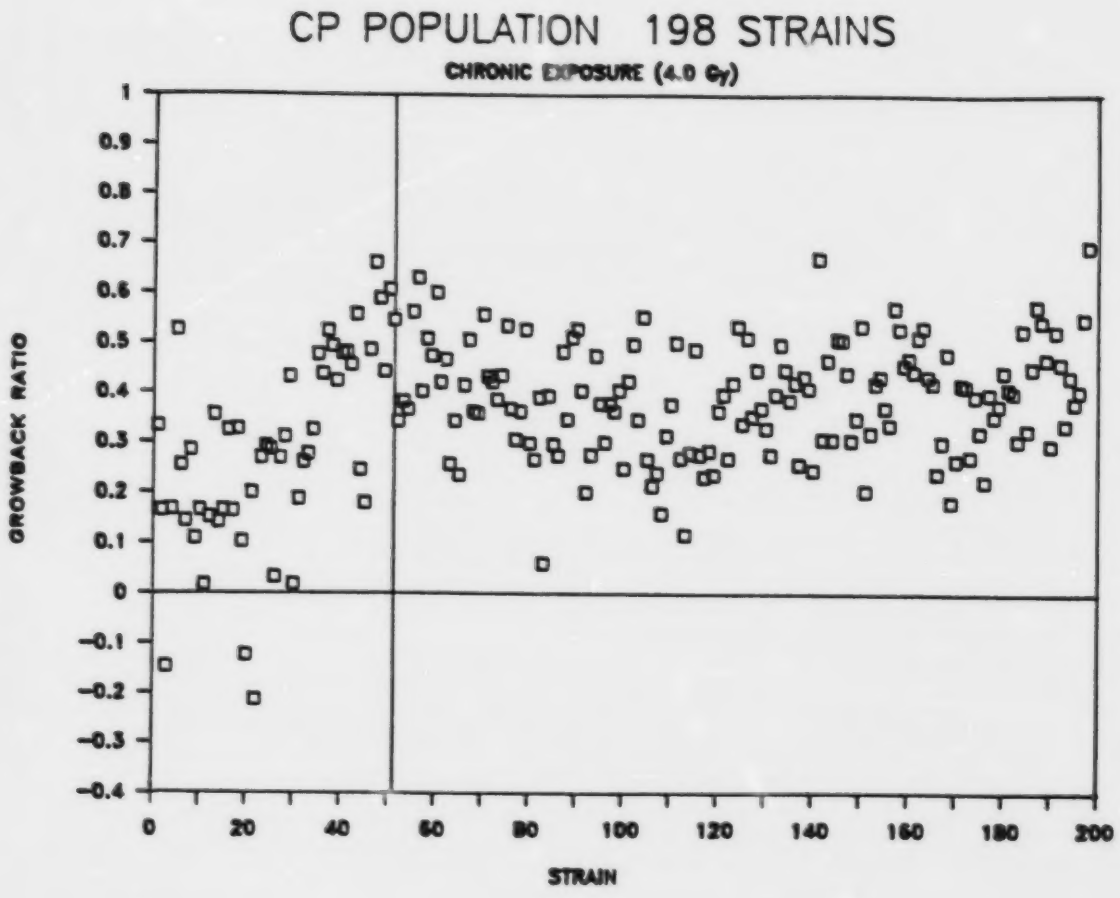


Fig. A-6 As for Fig. A-5, except that this represents the chronic-γ radiosensitivity test.



APPENDIX B

DATA-BASE SUMMARIES

(K. Gale, Radiation Biology Branch, CRNL)

Data-base print-outs of the relevant parameters for the in vitro radiosensitivity testing performed on various populations of LCL strains; figures of their radioresponse distributions.

Table B-I. CR database (ostensibly normal, volunteer CRNL donors) for the acute γ-exposure (1.7 Gy; dose-rate ~2 $Gy \cdot min^{-1}$) in vitro radiosensitivity tests.

CR NORMAL POPULATION 180 STRAINS

ACUTE EXPOSURE
****

STRAIN	#	GBR	DEVGBR	TYPE	PROB	SEX	AGE
CR0001	5	0.331933	0.137160	1	0.3152	M	44
CR0002	3	0.470637	0.028914	0	0.5883	M	59
CR0003	3	0.108136	0.070792	0	0.0309	F	45
CR0004	3	0.689595	0.036949	-1	0.0263	M	26
CR0005	4	0.376123	0.197420	1	0.6063	M	39
CR0006	3	0.656074	0.032393	-1	0.0277	M	60
CR0007	2	0.404214	0.074710	1	0.4560	F	37
CR0008	3	0.614595	0.044400	0	0.1002	M	26
CR0009	2	0.690208	0.052252	-1	0.1526	M	58
CR0010	3	0.542386	0.019678	-1	0.0934	M	36
CR0011	2	0.575801	0.028008	0	0.1701	M	52
CR0012	2	0.190861	0.219110	0	0.4027	M	43
CR0013	2	0.394701	0.036594	-1	0.2170	M	29
CR0014	3	0.493415	0.127790	-1	0.9782	M	54
CR0015	4	0.617543	0.022284	-1	0.0055	M	24
CR0016	2	0.365891	0.037621	0	0.1705	M	62
CR0017	2	0.383153	0.081785	0	0.4153	M	29
CR0018	3	0.554931	0.042522	-1	0.2607	F	29
CR0019	3	0.666528	0.071808	0	0.1302	M	22
CR0020	3	0.480651	0.059887	1	0.8970	M	59
CR0021	2	0.484866	0.030[illegible]6	-1	0.9038	F	26
CR0022	3	0.496516	0.064419	-1	0.9233	M	48
CR0023	2	0.252933	0.061727	-1	0.1556	M	42
CR0025	3	0.196510	0.027954	-1	0.0047	F	30
CR0026	2	0.339936	0.024481	0	0.0697	M	49
CR0027	2	0.471192	0.038766	-1	0.7126	F	42
CR0028	3	0.429625	0.056623	1	0.4013	M	32
CR0029	3	0.392136	0.013661	0	0.0033	F	41
CR0030	2	0.394107	0.051126	-1	0.3054	M	54
CR0031	2	0.365198	0.108770	-1	0.4567	M	46
CR0032	3	0.375444	0.056248	-1	0.1767	M	44
CR0033	3	0.338066	0.050111	-1	0.0895	F	29
CR0036	3	0.621071	0.023241	0	0.0175	M	43
CR0037	3	0.454699	0.069711	0	0.6683	M	29
CR0038	4	0.427605	0.037256	0	0.1951	M	48
CR0039	5	0.606711	0.030166	0	0.0149	M	44
CR0040	2	0.336784	0.058188	0	0.2244	M	49
CR0041	2	0.591921	0.029572	-1	0.1516	M	40
CR0043	4	0.612607	0.036500	-1	0.0390	M	48
CR0044	2	0.451472	0.013949	0	0.1462	M	45
CR0047	2	0.436291	0.074570	0	0.5891	M	37
CR0048	6	0.470846	0.029941	0	0.5742	M	45
CR0049	2	0.529307	0.132460	1	0.8052	M	56
CR0050	5	0.461918	0.026642	0	0.3735	F	21
CR0051	2	0.434145	0.087783	-1	0.6263	M	45
CR0052	2	0.512471	0.030732	0	0.5811	M	24
CR0053	2	0.468487	0.010197	-1	0.2166	M	26
CR0055	3	0.622816	0.037566	0	0.0631	M	30
CR0056	2	0.435332	0.086858	1	0.6297	M	29
CR0057	4	0.491491	0.105910	1	0.9860	M	42

CR0058	6	0.529217	0.034334	1	0.3084	M	22
CR0059	2	0.650368	0.058672	1	0.2153	M	41
CR0060	6	0.470459	0.039664	0	0.6585	F	27
CR0061	3	0.472361	0.074225	0	0.8397	F	32
CR0062	3	0.519733	0.042555	0	0.5533	F	26
CR0063	2	0.424898	0.054872	-1	0.4445	M	40
CR0064	2	0.599423	0.029391	0	0.1387	M	35
CR0065	2	0.635124	0.054408	1	0.2192	F	23
CR0066	5	0.408606	0.023112	0	0.0204	F	21
CR0067	2	0.597209	0.051288	1	0.2744	M	49
CR0068	3	0.631490	0.017401	-1	0.0039	M	33
CR0069	2	0.277455	0.094029	0	0.2630	M	44
CR0070	6	0.530740	0.057900	0	0.5116	M	41
CR0072	3	0.523430	0.055854	0	0.6066	M	28
CR0073	2	0.540838	0.007926	-1	0.0066	M	22
CR0074	3	0.302565	0.050791	-1	0.0621	M	54
CR0075	2	0.573987	0.038913	-1	0.2602	M	43
CR0076	5	0.556440	0.053153	0	0.2787	M	53
CR0077	2	0.539928	0.012157	0	0.0590	M	35
CR0078	2	0.449157	0.141800	-1	0.8152	M	39
CR0079	2	0.326707	0.146550	1	0.4661	M	23
CR0080	3	0.627948	0.020038	-1	0.0085	M	32
CR0081	2	0.430945	0.017027	0	0.1157	M	33
CR0082	2	0.625910	0.021526	0	0.0592	M	47
CR0085	2	0.527315	0.109210	-1	0.7779	M	53
CR0086	3	0.500974	0.079921	-1	0.8991	M	53
CR0087	2	0.642057	0.037105	0	0.1338	M	40
CR0088	2	0.556048	0.022360	-1	0.1635	M	64
CR0089	3	0.690733	0.101220	0	0.1841	M	39
CR0090	3	0.624472	0.073039	-1	0.2041	M	29
CR0091	2	0.637985	0.081305	1	0.3157	M	52
CR0092	2	0.579954	0.036135	0	0.2241	M	50
CR0093	3	-0.080937	0.023936	-1	0.0004	M	54
CR0094	2	0.528166	0.043206	0	0.5189	M	38
CR0095	3	0.524706	0.033716	-1	0.4071	F	46
CR0096	4	0.403993	0.044759	-1	0.1508	M	41
CR0097	3	0.515525	0.026976	-1	0.4404	M	23
CR0099	3	0.554730	0.027094	-1	0.1247	F	21
CR0100	5	0.464398	0.034438	1	0.5161	M	23
CR0101	2	0.434824	0.108200	-1	0.6886	M	40
CR0102	3	0.347355	0.102670	1	0.2998	F	21
CR0104	2	0.571064	0.080450	-1	0.4740	M	20
CR0105	4	0.440766	0.034066	-1	0.2502	M	20
CR0106	2	0.388645	0.082885	-1	0.4362	M	40
CR0107	2	0.460930	0.081001	-1	0.7751	F	19
CR0108	3	0.599289	0.072373	-1	0.2674	M	22
CR0109	6	0.254196	0.042360	0	0.0021	M	23
CR0110	2	0.356387	0.052559	-1	0.2306	F	20
CR0111	3	0.236804	0.036205	-1	0.0150	M	23
CR0112	3	0.481364	0.080135	1	0.9289	F	24
CR0113	3	0.346002	0.062114	1	0.1442	F	27
CR0114	5	0.552258	0.037093	1	0.1678	M	23
CR0115	3	0.636719	0.048163	1	0.0872	M	21
CR0116	2	0.614271	0.032663	0	0.1401	F	20
CR0117	2	0.565154	0.030134	-1	0.2165	M	40
CR0118	3	0.676605	0.047495	0	0.0538	M	32

CR0119	3	0.401361	0.081130	0	0.3906	M	50
CR0120	2	0.212225	0.010894	-1	0.0003	M	42
CR0121	3	0.332181	0.056169	-1	0.1035	M	63
CR0122	2	0.705981	0.071507	0	0.1980	F	21
CR0123	2	0.550626	0.050658	0	0.4357	M	22
CR0124	3	0.404859	0.036751	-1	0.1403	M	23
CR0125	1	0.599569	0.102710	-2	0.0000	M	31
CR0126	2	0.662850	0.040194	-1	0.1296	M	25
CR0127	2	0.635390	0.059997	-1	0.2416	M	21
CR0128	2	0.429861	0.046242	0	0.4138	M	22
CR0129	5	0.558996	0.021314	0	0.0261	M	31
CR0130	2	0.558538	0.083496	0	0.5411	M	27
CR0131	3	0.374594	0.045655	0	0.1228	F	22
CR0132	2	0.583445	0.062565	0	0.3696	M	20
CR0133	3	0.337925	0.048631	0	0.0843	M	60
CR0135	3	0.600148	0.049224	0	0.1491	M	22
CR0136	3	0.632678	0.037757	0	0.0554	M	19
CR0138	3	0.564772	0.024881	0	0.0779	M	19
CR0139	3	0.446392	0.077904	1	0.6365	F	21
CR0140	2	0.265037	0.046966	-1	0.1200	M	25
CR0143	3	0.477416	0.130040	-1	0.9346	M	21
CR0144	3	0.467971	0.042707	0	0.6675	F	21
CR0145	4	0.419671	0.115850	1	0.5900	M	21
CR0146	3	0.400960	0.115690	1	0.5242	M	26
CR0148	3	0.555321	0.058586	1	0.3775	F	20
CR0149	2	0.772228	0.071067	0	0.1515	M	37
CR0153	4	0.481924	0.038767	0	0.8607	F	18
CR0154	3	0.678599	0.040216	0	0.0364	M	44
CR0155	2	0.497574	0.057811	0	0.9083	M	42
CR0156	3	0.487005	0.054319	1	0.9681	M	41
CR0157	3	0.398122	0.037560	-1	0.1279	M	40
CR0158	3	0.649811	0.078741	0	0.1770	M	21
CR0159	2	0.323932	0.091580	1	0.3192	M	22
CR0160	2	0.522111	0.053754	0	0.6401	F	21
CR0161	3	0.541358	0.016000	-1	0.0552	M	20
CR0162	2	0.277324	0.090152	-1	0.2528	F	41
CR0163	2	0.435200	0.141310	1	0.7554	M	21
CR0167	2	0.452300	0.067247	1	0.6656	M	40
CR0168	3	0.477542	0.049033	0	0.8319	M	41
CR0169	2	0.520700	0.063335	-1	0.6971	M	29
CR0170	3	0.385583	0.026660	-1	0.0464	M	50
CR0171	3	0.611275	0.023813	-1	0.0230	M	37
CR0172	3	0.543585	0.056740	0	0.4413	M	29
CR0173	3	0.567801	0.023428	-1	0.0615	M	41
CR0174	2	0.387323	0.070880	1	0.3830	M	37
CR0175	2	0.508006	0.090621	-1	0.8659	M	57
CR0176	5	0.616259	0.040417	1	0.0330	F	21
CR0177	2	0.395759	0.057107	-1	0.3428	F	51
CR0178	3	0.393465	0.056100	0	0.2268	F	26
CR0179	4	0.373254	0.052526	-1	0.1121	F	49
CR0180	3	0.517696	0.049794	-1	0.6300	M	37
CR0181	2	0.102373	0.034364	-1	0.0420	M	36
CR0182	3	0.252827	0.067002	-1	0.0690	M	24
CR0183	3	0.410542	0.056686	0	0.2969	M	32
CR0189	3	0.507134	0.025917	-1	0.5743	M	38
CR0190	2	0.676592	0.056620	-1	0.1789	F	33

CR0191	3	0.483195	0.055039	-1	0.9202	M	48
CR0193	3	0.484811	0.051319	0	0.9364	M	55
CR0194	3	0.561129	0.024694	0	0.0848	F	30
CR0195	2	0.606259	0.035255	-1	0.1668	F	32
CR0196	2	0.546645	0.087033	1	0.6138	F	24
CR0197	5	0.450053	0.036909	0	0.3526	F	33
CR0198	5	0.516618	0.027572	-1	0.3941	M	43
CR0199	3	0.435284	0.050009	-1	0.3918	M	31
CR0200	2	0.577043	0.037976	-1	0.2448	M	49
CR0202	2	0.575810	0.034446	0	0.2222	F	39
CR0203	5	0.479456	0.010326	0	0.4844	M	42
CR0204	3	0.351366	0.052382	1	0.1144	F	49
CR0205	3	0.555379	0.054722	-1	0.3510	M	53
CR0206	2	0.504480	0.057983	-1	0.8331	F	31
CR0207	2	0.510515	0.042017	-1	0.6962	M	31
CR0208	2	0.375740	0.066743	0	0.3335	M	26
CR0209	3	0.607607	0.064127	-1	0.2047	F	41
CR0210	2	0.711115	0.037252	-1	0.0895	M	54

Table B-II. CR database (ostensibly normal, volunteer CRNL donors) for the chronic γ-exposure (4 Gy; dose-rate ~0.003Gy·min^{-1}) in vitro radiosensitivity tests.

CR NORMAL POPULATION 180 STRAINS

CHRONIC EXPOSURE
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STRAIN	#	GBR	DEVGBR	TYPE	PROB	SEX	AGE
CR0001	5	0.481714	0.021326	0	0.0006	M	44
CR0002	3	0.279430	0.036084	1	0.2767	M	59
CR0003	3	-0.042027	0.046529	1	0.0113	F	45
CR0004	3	0.596516	0.032966	-1	0.0086	M	26
CR0005	4	0.343571	0.018858	0	0.6290	M	39
CR0006	3	0.452989	0.032346	0	0.0506	M	60
CR0007	2	0.291603	0.115600	1	0.7750	F	37
CR0008	3	0.404158	0.055318	0	0.3221	M	26
CR0009	2	0.583817	0.047353	-1	0.1023	M	58
CR0010	3	0.511551	0.028654	0	0.0136	M	36
CR0011	2	0.314650	0.024969	-1	0.6047	M	52
CR0012	2	-0.026176	0.103560	-1	0.1753	M	43
CR0013	2	0.049727	0.074946	-1	0.1579	M	29
CR0014	3	0.271487	0.100530	-1	0.6074	M	54
CR0015	4	0.451163	0.053595	1	0.1108	M	24
CR0016	2	0.125692	0.038810	-1	0.0951	M	62
CR0017	2	0.316198	0.090930	-1	0.8840	M	29
CR0018	3	0.287659	0.053254	0	0.4920	F	29
CR0019	3	0.533211	0.018196	0	0.0008	M	22
CR0020	3	0.369300	0.035037	0	0.4040	M	59
CR0021	2	0.296234	0.066338	0	0.6718	F	26
CR0022	3	0.213868	0.037412	0	0.0752	M	48
CR0023	2	0.017464	0.104410	1	0.2002	M	42
CR0025	3	0.036781	0.152850	0	0.1923	F	30
CR0026	2	0.297925	0.030011	-1	0.4378	M	49
CR0027	2	0.076472	0.086686	1	0.2027	F	42
CR0028	3	0.226991	0.103660	1	0.4165	M	32
CR0029	4	0.263092	0.047783	1	0.2447	F	41
CR0030	2	0.331370	0.097945	0	0.9938	M	54
CR0031	2	0.081308	0.082115	-1	0.1954	M	46
CR0032	3	0.273800	0.063151	0	0.4529	M	44
CR0033	3	0.170473	0.091963	0	0.2191	F	29
CR0036	3	0.528496	0.018720	-1	0.0011	M	43
CR0037	3	0.234410	0.108530	1	0.4624	M	29
CR0038	4	0.244933	0.033041	0	0.0708	M	48
CR0039	5	0.372902	0.059167	0	0.5349	M	44
CR0040	2	0.282675	0.235690	1	0.8614	M	49
CR0041	2	0.385021	0.030405	0	0.3062	M	40
CR0043	4	0.447786	0.043975	0	0.0743	M	48
CR0044	2	0.436226	0.059757	1	0.3240	M	45
CR0047	2	0.282780	0.032806	1	0.3523	M	37
CR0048	6	0.316727	0.065231	1	0.8230	M	45
CR0049	2	0.315574	0.064117	0	0.8324	M	56
CR0050	5	0.337733	0.044136	0	0.9101	F	21
CR0051	2	0.305310	0.080727	-1	0.7867	M	45
CR0052	2	0.310067	0.076969	1	0.8144	M	24
CR0053	2	0.444979	0.027368	1	0.1081	M	26
CR0055	3	0.517959	0.043585	0	0.0429	M	30
CR0056	2	0.361169	0.168610	1	0.8868	M	29

CR0057	4	0.265217	0.100390	1	0.5532	M	42
CR0058	6	0.378038	0.050457	1	0.4135	M	22
CR0059	2	0.443870	0.090029	0	0.4297	M	41
CR0060	6	0.307792	0.047544	1	0.6356	F	27
CR0061	3	0.443478	0.077767	-1	0.2876	F	32
CR0062	3	0.333022	0.028874	0	0.9828	F	26
CR0063	2	0.231114	0.087146	1	0.4503	M	40
CR0064	2	0.519945	0.111130	1	0.3380	M	35
CR0065	2	0.401691	0.032767	0	0.2527	F	23
CR0066	5	0.174222	0.033091	0	0.0063	F	21
CR0067	2	0.431270	0.028108	-1	0.1339	M	49
CR0068	3	0.407448	0.086929	1	0.4788	M	33
CR0069	2	0.262497	0.038043	-1	0.2982	M	44
CR0070	6	0.317462	0.048255	0	0.7758	M	41
CR0072	3	0.481296	0.080919	0	0.2049	M	28
CR0073	2	0.403410	0.046252	1	0.3555	M	22
CR0074	3	0.225197	0.058272	-1	0.2038	M	54
CR0075	2	0.331537	0.015738	0	0.9722	M	43
CR0076	5	0.485627	0.084681	0	0.1446	M	53
CR0077	2	0.436098	0.076837	1	0.4018	M	35
CR0078	2	0.156386	0.053936	-1	0.1761	M	39
CR0079	2	0.305434	0.125450	1	0.8596	M	23
CR0080	3	0.480240	0.023016	0	0.0093	M	32
CR0081	2	0.376071	0.031344	1	0.3761	M	33
CR0082	2	0.615916	0.016984	-1	0.0040	M	47
CR0085	2	0.395316	0.106650	-1	0.6454	M	53
CR0086	3	0.318416	0.063762	-1	0.8491	M	53
CR0087	2	0.491848	0.025955	-1	0.0604	M	40
CR0088	2	0.459675	0.030882	1	0.1155	M	64
CR0089	3	0.561454	0.121350	1	0.1986	M	39
CR0090	3	0.503399	0.081266	-1	0.1675	M	29
CR0091	2	0.652390	0.052154	-1	0.0898	M	52
CR0092	2	0.568130	0.027672	-1	0.0413	M	50
CR0093	3	-0.268134	0.103030	1	0.0269	M	54
CR0094	2	0.472582	0.020161	-1	0.0354	M	38
CR0095	3	0.380380	0.028556	0	0.2259	F	46
CR0096	4	0.244767	0.033065	-1	0.0706	M	41
CR0097	3	0.283840	0.042271	1	0.3705	M	23
CR0099	3	0.321173	0.065444	1	0.8817	F	21
CR0100	5	0.255339	0.033158	1	0.0796	M	23
CR0101	2	0.458141	0.153390	-1	0.5426	M	40
CR0102	3	0.201384	0.089284	0	0.2793	F	21
CR0104	2	0.395345	0.067750	-1	0.5044	M	20
CR0105	4	0.337054	0.041512	-1	0.9180	M	20
CR0106	2	0.305643	0.100660	-1	0.8283	M	40
CR0107	2	0.172375	0.096565	0	0.3427	F	19
CR0108	3	0.477259	0.057582	0	0.1229	M	22
CR0109	6	0.108724	0.057294	0	0.0106	M	23
CR0110	2	0.159620	0.030884	-1	0.0792	F	20
CR0111	3	0.115798	0.054790	-1	0.0529	M	23
CR0112	3	0.410442	0.122760	1	0.5898	F	24
CR0113	3	0.301749	0.097039	0	0.7834	F	27
CR0114	5	0.474486	0.067930	1	0.1041	M	23
CR0115	3	0.601142	0.062047	1	0.0451	M	21
CR0116	2	0.337039	0.023007	-1	0.8742	F	20
CR0117	2	0.518771	0.059107	1	0.1843	M	40

CR0118	3	0.562708	0.064636	0	0.0662 M	32
CR0119	3	0.042914	0.065499	0	0.0438 M	50
CR0120	2	0.038245	0.037925	-1	0.0607 M	42
CR0121	3	0.140680	0.070261	0	0.1085 M	63
CR0122	2	0.692339	0.035909	-1	0.0431 F	21
CR0123	2	0.352359	0.101550	1	0.8705 M	22
CR0124	3	0.289155	0.031638	0	0.3036 M	23
CR0125	1	0.542091	0.098592	-2	0.0000 M	31
CR0126	2	0.533085	0.144780	1	0.3966 M	25
CR0127	2	0.479974	0.044125	-1	0.1655 M	21
CR0128	2	0.390721	0.026065	-1	0.2253 M	22
CR0129	5	0.449208	0.073427	1	0.1875 M	31
CR0130	2	0.432036	0.064393	-1	0.3586 M	27
CR0131	3	0.186844	0.043689	1	0.0706 F	22
CR0132	2	0.105053	0.155540	1	0.3811 M	20
CR0133	3	0.186334	0.039673	0	0.0563 M	60
CR0135	3	0.483688	0.087322	1	0.2235 M	22
CR0136	3	0.434474	0.182610	1	0.6321 M	19
CR0138	3	0.507192	0.037110	0	0.0323 M	19
CR0139	3	0.367186	0.096454	1	0.7528 F	21
CR0140	2	0.111901	0.050847	1	0.1296 M	25
CR0143	3	0.333304	0.134820	-1	0.9947 M	21
CR0144	3	0.101633	0.028700	-1	0.0071 F	21
CR0145	4	0.262593	0.154740	1	0.6835 M	21
CR0146	3	0.309525	0.052874	0	0.7116 M	26
CR0148	3	0.484361	0.037082	1	0.0437 F	20
CR0149	2	0.515324	0.088369	1	0.2819 M	37
CR0153	4	0.435234	0.057953	0	0.1729 F	18
CR0154	3	0.216696	0.050424	0	0.1426 M	44
CR0155	2	0.366914	0.046655	0	0.5816 M	42
CR0156	3	0.259943	0.022680	-1	0.0615 M	41
CR0157	3	0.189888	0.122370	1	0.3642 M	40
CR0158	3	0.302164	0.120460	0	0.8262 M	21
CR0159	2	0.238238	0.197410	1	0.7034 M	22
CR0160	2	0.366976	0.115490	1	0.8060 F	21
CR0161	3	0.357680	0.034684	0	0.5469 M	20
CR0162	2	-0.188075	0.034147	0	0.0247 F	41
CR0163	2	0.217854	0.082727	-1	0.3951 M	21
CR0167	2	0.329191	0.052616	0	0.9617 M	40
CR0168	3	0.453265	0.086629	-1	0.2962 M	41
CR0169	2	0.318829	0.103140	1	0.9138 M	29
CR0170	3	0.213304	0.141500	1	0.4889 M	50
CR0171	3	0.582780	0.025101	-1	0.0031 M	37
CR0172	3	0.250923	0.129970	1	0.5954 M	29
CR0173	3	0.357876	0.023842	-1	0.4043 M	41
CR0174	2	0.403419	0.167060	0	0.7316 M	37
CR0175	2	0.297570	0.098926	-1	0.7760 M	57
CR0176	5	0.547001	0.023734	0	0.0002 F	21
CR0177	2	0.220669	0.099854	0	0.4629 F	51
CR0178	3	0.243046	0.092094	-1	0.4348 F	26
CR0179	4	0.235032	0.031393	-1	0.0457 F	49
CR0180	3	0.396228	0.045676	0	0.2940 M	37
CR0181	2	-0.152509	0.176970	1	0.2216 M	36
CR0182	3	-0.055227	0.028273	-1	0.0017 M	24
CR0183	3	0.145977	0.090349	0	0.1734 M	32
CR0189	3	0.468804	0.073352	0	0.2013 M	38

CR0190	2	0.421164	0.026013	0	0.1337	F	33
CR0191	3	0.210654	0.059084	-1	0.1715	M	48
CR0193	3	0.346756	0.061849	0	0.8382	M	55
CR0194	3	0.411596	0.075598	1	0.4042	F	30
CR0195	2	0.395637	0.036834	-1	0.3159	F	32
CR0196	2	0.410383	0.032387	-1	0.2195	F	24
CR0197	5	0.290485	0.056316	1	0.5043	F	33
CR0198	5	0.401720	0.026258	0	0.0540	M	43
CR0199	3	0.188262	0.086524	0	0.2364	M	31
CR0200	2	0.402759	0.097499	1	0.5846	M	49
CR0202	2	0.318648	0.052829	-1	0.8351	F	39
CR0203	5	0.409225	0.042390	0	0.1452	M	42
CR0204	3	0.107561	0.094450	1	0.1384	F	49
CR0205	2	0.444140	0.132900	0	0.5346	M	53
CR0206	2	0.332392	0.063779	0	0.9990	F	31
CR0207	2	0.225365	0.013848	-1	0.0110	M	31
CR0208	2	0.248087	0.050869	-1	0.3354	M	26
CR0209	3	0.295892	0.081105	-1	0.6986	F	41
CR0210	2	0.465027	0.019778	0	0.0364	M	54

Table B-III. CP1 (CP = cancer patient) data-base (strain numbers up to and including 106) for the acute-γ testing; includes some donors "selected" by the oncologists because of indications of clinical hypersensitivity.

CP1 POPULATION 51 STRAINS

ACUTE EXPOSURE
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STRAIN	#	GBR	DEVGBR	TYP	PROB	CLINIC#	SRCE	SEX	AGE	TYPE CA
CP0005C	1	0.265281	0.190560	-2	0.0000	851198	OTT	F		ESOPHAGUS
CP0010C	2	0.384467	0.146400	-1	0.5854	871025	OTT	M	58	CERVIX III
CP0011C	4	0.291720	0.080469	-1	0.0902	870136	OTT	F	68	PROSTATE
CP0016C	3	0.425771	0.067137	-1	0.4431	851046	OTT	F		BLADDER II
CP0018C	2	0.571217	0.086871	-1	0.4986	851506	OTT	M		
CP0019C	5	0.190371	0.020838	0	0.0000	880167	LON	F		PROSTATE
CP0020C	3	0.445668	0.116920	-1	0.7441	880373	LON	M	25	SEMINOMA III
CP0021C	2	0.450534	0.130750	-1	0.8070	880317	LON			
CP0022C	5	0.399301	0.045914	-1	0.1211	630709	LON	M	31	CERVIX
CP0023C	4	0.453118	0.085085	0	0.6990	880401	LON	M	73	PROSTATE
CP0024C	5	0.374030	0.052235	-1	0.0911	889007	LON	M	61	PROSTATE
CP0029C	2	0.430994	0.183300	-1	0.7938	880574	LON	F	41	BREAST
CP0030C	1	0.517399	0.158830	-2	0.0000	880504	LON	M	66	PROSTATE
CP0031C	2	0.381080	0.190370	-1	0.6546	880144	LON			
CP0032C	3	0.524859	0.109270	-1	0.7770	889014	LON	F		
CP0038C	2	0.477685	0.148340	-1	0.9471	880566	LON	M	47	LUNG
CP0039C	3	0.349997	0.113460	0	0.3435	880598	LON	F		
CP0040C	3	0.446207	0.079719	-1	0.6424	880642	LON	M	35	TESTIS
CP0044C	2	0.305300	0.109180	-1	0.3390	880829	LON	M	74	ENDOMETRIUM
CP0045C	2	0.224085	0.032117	0	0.0578	870369	LON		70	PROSTATE
CP0048C	2	0.429684	0.127830	-1	0.7084	880842	LON	M	50	BREAST
CP0049C	2	-0.136801	0.403580	1	0.3643	870742	LON	M	49	BREAST
CP0055C	3	0.359909	0.053172	-1	0.1310	870648	OTT	F		
CP0056C	3	0.497643	0.108840	-1	0.9471	881209	LON	M	70	COLON
CP0058C	2	0.470606	0.091899	-1	0.8654	881278	LON	M	71	LARYNX
CP0060C	2	0.226633	0.076451	-1	0.1757	880642	OTT	F	50	MULT MYELOMA
CP0061C	3	0.386869	0.099805	-1	0.4118	880076	LON	M	64	BREAST
CP0062C	2	0.390219	0.129120	-1	0.5636	881345	LON		59	SFT PALATE
CP0065C	2	0.549086	0.095514	-1	0.6290	881130	LON		64	MELANOMA
CP0066C	2	0.380453	0.077149	-1	0.3894	881027	OTT	M	80	LARYNX
CP0069C	3	0.324936	0.059651	-1	0.1067	881371	LON		39	TONSIL
CP0070C	3	0.376550	0.101300	-1	0.3806	881750	LON	M	49	TONSIL
CP0076C	3	0.350224	0.086939	-1	0.2495	800193	OTT	F	78	VAGINA
CP0077C	2	0.468337	0.133550	-1	0.8953	880889	OTT	M	47	?SQ CL LYMPH
CP0078C	2	0.454579	0.062225	-1	0.6620	881201	OTT	F	48	BREAST
CP0079C	4	0.394411	0.084650	-1	0.3439	881249	OTT	F		
CP0080C	2	0.526538	0.066672	-1	0.6641	881898	LON		59	LARYNX
CP0083C	4	0.589105	0.058224	-1	0.1851	881316	OTT	M		
CP0084C	3	0.402284	0.053103	-1	0.2400	881308	OTT	F	61	SUPERGLOTTIS
CP0085C	2	0.499429	0.110730	-1	0.9403	860908	LON	F	74	BREAST
CP0087C	2	0.597318	0.060875	-1	0.3218	881293	OTT	F	62	BREAST
CP0088C	2	0.518936	0.086036	-1	0.7808	881352	OTT	F	79	BREAST
CP0091C	2	0.467622	0.066380	-1	0.7897	582195	LON	M		
CP0094C	3	0.486387	0.063814	-1	0.9660	881394	OTT	M		
CP0095C	2	0.419986	0.065407	-1	0.4784	881396	OTT	F		
CP0098C	2	0.539326	0.113360	-1	0.7240	881474	OTT	F		
CP0100C	2	0.569811	0.119580	-1	0.6061	871451	OTT	F	66	BREAST
CP0101C	2	0.435219	0.258970	-1	0.8619	881477	OTT	M		
CP0102C	2	0.503574	0.085743	-1	0.8918	881516	OTT	F		
CP0104C	2	0.585680	0.124020	-1	0.5607	881560	OTT	M		
CP0106C	2	0.488437	0.075611	-1	0.9909	881556	OTT	F		

Table B-IV. CP2 database (strain numbers 107 and up) for the acute γ-exposure testing: freshly presented, non-selected cancer patient donors from the ORCC (Ottawa Regional Cancer Clinic).

CP2 POPULATION 147 STRAINS

ACUTE EXPOSURE
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STRAIN #	GBR	DEVGBR	TYP	PROB	CLINIC#	SRCE	SEX	AGE	TYPE CA
CP0107C 2	0.419318	0.072990	-1	0.4922	881529	OTT	F		
CP0108C 3	0.486698	0.063856	-1	0.9694	881310	OTT	F		
CP0109C 3	0.414300	0.085696	-1	0.4730	881562	OTT	F	76	COLON
CP0115C 2	0.572758	0.037325	0	0.2523	881598	OTT	F		
CP0123C 3	0.667019	0.038719	-1	0.0379	881629	OTT	F		
CP0127C 3	0.630926	0.040059	-1	0.0646	881701	OTT	F	38	RECTOSIGMOID
CP0130C 2	0.583859	0.035092	0	0.2073	881711	OTT	F	60	OVARY
CP0131C 3	0.616754	0.038443	0	0.0726	881724	OTT	F	48	BREAST
CP0134C 3	0.592985	0.018221	0	0.0129	881687	OTT	M	66	TONGUE
CP0140C 2	0.495180	0.025458	-1	0.8602	881700	OTT	M	65	PROSTATE
CP0141C 3	0.545096	0.114500	-1	0.6754	881254	OTT	F	65	BLADDER
CP0144C 3	0.487815	0.077667	-1	0.9850	881698	OTT	F	70	BREAST
CP0145C 2	0.475133	0.073089	-1	0.8717	890009	OTT	F	60	BREAST
CP0146C 2	0.431217	0.118550	-1	0.6957	670699	OTT	F	58	MELANOMA
CP0147C 2	0.524632	0.093220	-1	0.7602	890006	OTT	M	72	BCC NOSE
CP0148C 2	0.548394	0.080001	-1	0.5786	890007	OTT	F	75	BCC NOSE
CP0149C 2	0.485669	0.057764	-1	0.9567	890017	OTT	F	57	MELANOMA
CP0150C 2	0.434684	0.074402	0	0.5790	890018	OTT	F	53	BREAST
CP0151C 2	0.555936	0.107640	-1	0.6318	890005	OTT	M	63	BCC SKIN
CP0152C 3	0.483106	0.073902	-1	0.9394	890035	OTT	F	78	BREAST
CP0153C 2	0.407215	0.058968	0	0.3915	890046	OTT	M	69	COLON
CP0154C 2	0.560033	0.072904	-1	0.4899	890030	OTT	F	67	BREAST
CP0156C 2	0.523225	0.102230	-1	0.7878	890024	OTT	F	58	COLON
CP0157C 2	0.504886	0.069535	-1	0.8557	890055	OTT	M	67	PROSTATE
CP0159C 3	0.521069	0.098592	-1	0.7793	890031	OTT	F	70	BREAST
CP0163C 1	0.440220	0.260510	-2	0.0000	890037	OTT	F	50	BREAST
CP0164C 2	0.372402	0.075289	0	0.3607	890039	OTT	F	61	BREAST
CP0165C 2	0.612356	0.140670	-1	0.5219	890054	OTT	F	44	BREAST
CP0166C 2	0.393638	0.033883	-1	0.1955	890058	OTT	F	58	BREAST
CP0167C 2	0.450190	0.097711	-1	0.7457	890060	OTT	F	73	ESOPHAGUS
CP0168C 2	0.380127	0.088809	0	0.4326	890061	OTT	M	38	PANCREAS
CP0169C 2	0.472029	0.108000	-1	0.8934	890049	OTT	F	51	LUNG
CP0170C 2	0.430070	0.073888	-1	0.5508	890072	OTT	F	59	BREAST
CP0171C 2	0.444756	0.031376	-1	0.3752	890075	OTT	F	59	LUNG
CP0172C 2	0.390019	0.064705	-1	0.3631	890084	OTT	M	47	RECTUM
CP0173C 2	0.491459	0.089369	-1	0.9852	890023	OTT	F	37	SQU C CHEEK
CP0174C 2	0.428142	0.088747	-1	0.5982	890059	OTT	M	47	BCC EYELID
CP0175C 2	0.554988	0.120090	-1	0.6673	890082	OTT	M	70	COLON
CP0176C 2	0.513400	0.111850	-1	0.8596	890096	OTT	F	71	COLON
CP0177C 2	0.393319	0.154780	-1	0.6294	890101	OTT	F	37	COLON
CP0184C 2	0.370543	0.035412	-1	0.1645	890114	OTT	M	79	BCC SCALP
CP0185C 2	0.501862	0.107900	-1	0.9239	890159	OTT	F	62	BREAST
CP0186C 2	0.538134	0.074118	-1	0.6147	890130	OTT	M	58	COLON
CP0187C 2	0.362787	0.113070	-1	0.4630	890112	OTT	M	75	COLON
CP0188C 2	0.483338	0.082596	-1	0.9508	890156	OTT	F	65	BREAST
CP0189C 2	0.517675	0.069483	-1	0.7447	890151	OTT	F	73	BREAST
CP0190C 2	0.495887	0.100280	-1	0.9575	890131	OTT	F	61	BREAST
CP0191C 2	0.455355	0.089804	-1	0.7587	890174	OTT	F	60	RECTUM
CP0192C 2	0.391802	0.048090	0	0.2819	890178	OTT	M		STOMACH
CP0195C 2	0.506726	0.116870	-1	0.9023	890155	OTT	M	66	RECTUM
CP0196C 1	0.486431	0.143190	-2	0.0000	890183	OTT	F	74	BREAST

CP0197C	2	0.499950	0.087197	-1	0.9206	890175	OTT	M	45	LUNG
CP0198C	2	0.801870	0.653380	-1	0.7019	890153	OTT	M	67	PROSTATE
CP0199C	2	0.489671	0.094047	-1	0.9986	890193	OTT	M	58	PROSTATE
CP0200C	2	0.428641	0.106780	-1	0.6553	890163	OTT	F	50	BREAST
CP0201C	2	0.398566	0.094282	-1	0.4903	890160	OTT	F	47	RECTUM
CP0203C	2	0.349286	0.072092	-1	0.2982	890221	OTT	M	60	MOUTH
CP0204C	2	0.490861	0.127540	-1	0.9927	890248	OTT	M	69	LARYNX
CP0205C	2	0.501030	0.059763	-1	0.8740	890207	OTT	F	44	BREAST
CP0206C	2	0.557492	0.092287	-1	0.5778	890186	OTT	F	81	LYMPHOMA
CP0207C	2	0.495646	0.116170	-1	0.9646	890225	OTT	F	65	LARYNX
CP0208C	1	0.367521	0.350530	-2	0.0000	410072	OTT	F	74	BREAST
CP0209C	2	0.509630	0.141630	-1	0.9057	890093	OTT	F	47	BREAST
CP0210C	2	0.523287	0.075609	-1	0.7211	890190	OTT	F	52	BREAST
CP0211C	2	0.426339	0.064975	-1	0.4891	890209	OTT	F	54	BREAST
CP0213C	2	0.524927	0.209610	-1	0.8880	890208	OTT	F	68	BREAST
CP0214C	2	0.442597	0.052944	-1	0.5211	890254	OTT	F	55	BREAST
CP0215C	2	0.466728	0.102250	-1	0.8543	890234	OTT	M	66	MET CA
CP0216C	2	0.463777	0.098378	-1	0.8300	890235	OTT	M	58	TONGUE
CP0217C	2	0.537736	0.099620	-1	0.6999	890240	OTT	M	55	BRAIN
CP0218C	2	0.482258	0.218420	-1	0.9779	890255	OTT	F	74	RECTUM
CP0219C	2	0.606909	0.118560	-1	0.4808	890230	OTT	M	71	SALIVARY GL
CP0220C	2	0.433253	0.114430	0	0.6959	890210	OTT	M	70	LYMPHOMA
CP0221C	2	0.455809	0.146170	0	0.8489	890253	OTT	M	72	LUNG
CP0223C	2	0.591086	0.081541	-1	0.4285	890245	OTT	F	48	BREAST
CP0224C	2	0.527967	0.070348	-1	0.6683	890200	OTT	F	39	BREAST
CP0226C	2	0.543571	0.125610	-1	0.7290	890162	OTT	F	24	SARCOMA
CP0227C	2	0.522001	0.094355	-1	0.7792	890262	OTT	F	43	BREAST
CP0228C	2	0.441497	0.075251	-1	0.6235	890238	OTT	M	62	LUNG
CP0229C	2	0.409861	0.299340	-1	0.8262	890276	OTT	M	44	GLIOBLASTOMA
CP0230C	2	0.461209	0.108570	-1	0.8304	890273	OTT	F	30	BREAST
CP0231C	2	0.518774	0.136260	-1	0.8587	890247	OTT	M	68	PROSTATE
CP0236C	2	0.479868	0.072360	-1	0.9126	890302	OTT	M	77	LIVER
CP0237C	2	0.471355	0.051914	-1	0.7792	890330	OTT	F	54	BREAST
CP0240C	2	0.466935	0.115140	0	0.8712	881162	OTT	F	66	
CP0241C	2	0.518595	0.059581	-1	0.6998	890318	OTT	M	49	RECTUM
CP0242C	2	0.539414	0.036065	-1	0.3874	890322	OTT	M	50	BCC SKIN
CP0243C	2	0.573576	0.120510	-1	0.5943	890332	OTT	F	64	BREAST
CP0244C	3	0.536661	0.196780	-1	0.8328	890334	OTT	M	60	SKIN
CP0245C	2	0.723877	0.114290	-1	0.2871	890242	OTT	M	67	PROSTATE
CP0248C	2	0.544529	0.097962	-1	0.6594	890337	OTT	F	58	BREAST
CP0249C	2	0.559841	0.084270	0	0.5379	890317	OTT	F	40	BREAST
CP0250C	2	0.433215	0.063239	-1	0.5185	890375	OTT	M	40	BRAIN
CP0251C	2	0.678051	0.193700	-1	0.4859	890361	OTT	M	54	LUNG
CP0255C	2	0.529479	0.096175	0	0.7378	890395	OTT	F	37	COLON
CP0256C	2	0.464387	0.042054	0	0.6475	890384	OTT	F	59	BREAST
CP0259C	2	0.496571	0.077315	-1	0.9393	890440	OTT	M	70	LARYNX
CP0260C	2	0.616948	0.096558	-1	0.4111	890424	OTT	F	31	HODGKINS
CP0261C	2	0.577915	0.104510	-1	0.5329	890408	OTT	F	53	BREAST
CP0262C	2	0.429991	0.092392	-1	0.6198	890419	OTT	F	56	SFT PALATE
CP0264C	2	0.451441	0.074957	-1	0.6886	890427	OTT	M	59	ORAL
CP0265C	2	0.652936	0.110610	-1	0.3773	890310	OTT	F	75	NECK
CP0267C	2	0.631683	0.118350	-1	0.4410	890394	OTT	M	60	PROSTATE
CP0269C	2	0.505100	0.145480	-1	0.9286	890417	OTT	M	69	SKIN
CP0270C	2	0.458521	0.185270	-1	0.8894	890428	OTT	F	57	BREAST
CP0272C	2	0.600207	0.130990	-1	0.5328	890425	OTT	M	62	COLON
CP0273C	2	0.593025	0.117120	-1	0.5183	890432	OTT	F	59	BREAST

CP0274C	2	0.548759	0.132680	-1	0.7198	890431	OTT	F 61	BREAST
CP0275C	2	0.486322	0.096027	-1	0.9782	890499	OTT	M 36	TONSIL
CP0276C	2	0.552716	0.109720	-1	0.6519	890507	OTT	F 35	BREAST
CP0277C	2	0.603638	0.079459	-1	0.3845	890534	OTT	M 69	RECTUM
CP0278C	2	0.441651	0.056200	-1	0.5338	890497	OTT	M 57	LARYNX
CP0280C	2	0.529766	0.083633	-1	0.7019	890533	OTT	F 45	BREAST
CP0281C	2	0.528664	0.071370	-1	0.6672	890479	OTT	F 57	BRAIN
CP0282C	2	0.373012	0.035929	-1	0.1714	890542	OTT	F 47	BREAST
CP0283C	2	0.479115	0.051899	0	0.8706	890551	OTT	F 69	BREAST
CP0284C	2	0.619385	0.133480	-1	0.4864	890550	OTT	F 49	BREAST
CP0285C	2	0.413485	0.104190	1	0.5808	890576	OTT	F 57	BREAST
CP0286C	2	0.438817	0.040360	-1	0.4207	890600	OTT	F 60	BREAST
CP0287C	2	0.563545	0.080274	-1	0.5053	890521	OTT	M 78	PROSTATE?
CP0288C	2	0.442641	0.053374	-1	0.5241	890516	OTT	M 56	LARYNX
CP0289C	2	0.473867	0.039068	0	0.7524	890609	OTT	F 53	THROAT
CP0290C	2	0.490534	0.057598	0	0.9879	890624	OTT	F 57	MANDIBLE
CP0291C	2	0.541969	0.079816	-1	0.6138	890643	OTT	M 58	LARYNX
CP0292C	2	0.412828	0.120880	-1	0.6236	890618	OTT	F 72	BREAST
CP0293C	2	0.517478	0.074638	-1	0.7621	890604	OTT	F 73	BREAST
CP0295C	2	0.478925	0.096772	-1	0.9278	890621	OTT	M 31	PAROTID
CP0297C	2	0.501395	0.101580	-1	0.9222	890639	OTT	M 53	RECTUM
CP0298C	2	0.514863	0.171270	-1	0.9017	890644	OTT	M 56	OROPHARYNX
CP0300C	2	0.508147	0.065547	-1	0.8165	890651	OTT	M 64	BREAST
CP0304C	2	0.546952	0.155370	-1	0.7636	890596	OTT	F 64	BCC NOSE
CP0305C	2	0.504956	0.119450	-1	0.9141	890623	OTT	F 55	MAL MELANOMA
CP0307C	2	0.595247	0.095989	-1	0.4680	890694	OTT	M 67	LARYNX TONSIL
CP0308C	2	0.501024	0.093988	-1	0.9187	890192	OTT	F 69	NOSTRIL
CP0309C	1	0.395872	0.122150	-2	0.0000	890677	OTT	F 55	LARYNX
CP0311C	2	0.530954	0.134380	-1	0.8003	890682	OTT	F 52	RECTUM
CP0313C	2	0.568952	0.113320	-1	0.5929	890724	OTT	F 67	MOUTH
CP0314C	2	0.531070	0.126440	-1	0.7881	890704	OTT	M 64	LUNG
CP0315C	2	0.505054	0.059965	-1	0.8323	890715	OTT	F 66	BREAST
CP0316C	2	0.499995	0.097706	-1	0.9286	890723	OTT	F 54	BREAST
CP0317C	2	0.624231	0.074523	-1	0.3179	890728	OTT	F 66	BREAST
CP0318C	2	0.546855	0.068151	-1	0.5362	890744	OTT	F 44	LARYNX
CP0319C	2	0.412630	0.144310	-1	0.6737	890635	OTT	F 67	LUNG
CP0320C	2	0.567818	0.151560	-1	0.6818	890731	OTT	F 55	BREAST
CP0321C	2	0.499244	0.066793	-1	0.9040	890722	OTT	M 55	OESOPHAGUS
CP0329C	2	0.631866	0.130450	-1	0.4715	890772	OTT	M 59	PITUITARY
CP0335C	2	0.773690	0.162890	-1	0.3305	861252	OTT	F 62	ENDOMET UTUS

Table B-V. CP1 database (includes "selected" cancer patient donors) for the chronic γ-exposure in vitro radiosensitivity testing.

CP1 POPULATION 51 STRAINS

CHRONIC EXPOSURE

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STRAIN	#	GBR	DEVGBR	TYP	PROB	CLINIC#	SRCE	SEX	AGE	TYPE CA
CP0005	1	0.333300	0.229070	-2	0.2409	651198	OTT	F		ESOPHAGUS
CP0010C	2	0.164409	0.192340	-1	0.5221	871025	OTT	M	58	CERVIX III
CP0011C	4	-0.146215	0.222490	0	0.1205	870136	OTT	F	68	PROSTATE
CP0016C	3	0.167800	0.021183	0	0.0045	851046	OTT	F		BLADDER II
CP0018C	2	0.526175	0.083138	-1	0.2526	851506	OTT	M		
CP0019C	5	0.255122	0.375240	-1	0.8472	880167	LON	F		PROSTATE
CP0020C	3	0.144616	0.060238	0	0.0844	880373	LON	M	25	SEMINOMA III
CP0021C	2	0.286149	0.161670	-1	0.8146	880317	LON			
CP0022C	5	0.109341	0.107270	0	0.1061	630709	LON	M	31	CERVIX
CP0023C	4	0.166519	0.158770	1	0.3735	880401	LON	M	73	PROSTATE
CP0024C	4	0.017398	0.047467	0	0.0053	889007	LON	M	61	PROSTATE
CP0029C	2	0.152886	0.102650	-1	0.3280	880574	LON	F	41	BREAST
CP0030C	1	0.356262	0.126660	-2	0.0000	880504	LON	M	66	PROSTATE
CP0031C	2	0.141656	0.093992	-1	0.2878	880144	LON			
CP0032C	3	0.166618	0.089090	0	0.2023	889014	LON	F		
CP0038C	2	0.326139	0.116000	-1	0.9648	880566	LON	M	47	LUNG
CP0039C	3	0.164509	0.092036	0	0.2083	880598	LON	F		
CP0040C	3	0.327935	0.096784	0	0.9683	880642	LON	M	35	TESTIS
CP0044C	2	0.103604	0.107320	-1	0.2763	880829	LON	M	74	ENDOMETRIUM
CP0045C	2	-0.122044	0.113390	1	0.1525	870369	LON		70	PROSTATE
CP0048C	2	0.201312	0.113650	-1	0.4536	880842	LON	M	50	BREAST
CP0049C	2	-0.212139	0.271590	0	0.2941	870742	LON	M	49	BREAST
CP0055C	3	0.271030	0.058055	-1	0.4022	870648	OTT	F		
CP0056C	3	0.293521	0.087606	-1	0.7023	881209	LON	M	70	COLON
CP0058C	2	0.287296	0.030095	-1	0.3525	881278	LON	M	71	LARYNX
CP0060C	2	0.032318	0.062418	-1	0.1207	880642	OTT	F	50	MULT MYELOMA
CP0061C	3	0.270435	0.097549	-1	0.5915	880076	LON	M	64	BREAST
CP0062C	2	0.312657	0.125850	-1	0.8970	881345	LON		59	SFT PALATE
CP0065C	2	0.432611	0.087604	-1	0.4547	881130	LON		64	MELANOMA
CP0066C	2	0.018292	0.034134	0	0.0460	881027	OTT	M	80	LARYNX
CP0069C	3	0.189023	0.116370	0	0.3429	881371	LON		39	TONSIL
CP0070C	3	0.262621	0.072120	0	0.4363	881750	LON	M	49	TONSIL
CP0076C	3	0.278265	0.067928	0	0.5109	800193	OTT	F	78	VAGINA
CP0077C	2	0.326784	0.039372	0	0.9108	880889	OTT	M	47	?SQ CL LYMPH
CP0078C	2	0.478019	0.060115	-1	0.2390	881201	OTT	F	48	BREAST
CP0079C	4	0.438166	0.079476	-1	0.2756	881249	OTT	F		
CP0080C	2	0.525107	0.080131	0	0.2450	881898	LON		59	LARYNX
CP0083C	4	0.494152	0.067164	-1	0.0932	881316	OTT	M		
CP0084C	3	0.423951	0.115630	0	0.5112	881308	OTT	F	61	SUPERGLOTTIS
CP0085C	2	0.479888	0.113980	-1	0.4170	860908	LON	F	74	BREAST
CP0087C	2	0.482739	0.042234	0	0.1532	881293	OTT	F	62	BREAST
CP0088C	2	0.456547	0.052048	-1	0.2394	881352	OTT	F	79	BREAST
CP0091C	2	0.558221	0.097755	0	0.2561	582195	LON	M		
CP0094C	3	0.246540	0.343170	0	0.8259	881394	OTT	M		
CP0095C	2	0.180460	0.074514	-1	0.2844	881396	OTT	F		
CP0098C	2	0.486874	0.115950	-1	0.4080	881474	OTT	F		
CP0100C	2	0.661759	0.124230	-1	0.2270	871451	OTT	F	66	BREAST
CP0101C	2	0.589247	0.108020	-1	0.2501	881477	OTT	M		
CP0102C	2	0.442791	0.099285	-1	0.4643	881516	OTT	F		
CP0104C	2	0.608170	0.123920	-1	0.2664	881560	OTT	M		
CP0106C	2	0.545880	0.062563	-1	0.1713	881556	OTT	F		

Table B-VI. CP2 database (unselected, freshly presented cancer patient donors) for the chronic γ-exposure radiosensitivity testing.

CP2 POPULATION 147 STRAINS

CHRONIC EXPOSURE

****

STRAIN	#	GBR	DEVGBR	TYP	PROB	CLINIC#	SRCE	SEX	AGE	TYPE CA
CP0107C	2	0.343030	0.147410	0	0.9515	881529	OTT	F		
CP0108C	3	0.383187	0.070052	-1	0.5443	881310	OTT	F		
CP0109C	3	0.366974	0.076165	-1	0.6948	881562	OTT	F	76	COLON
CP0115C	2	0.562321	0.095688	1	0.2469	881598	OTT	F		
CP0123C	3	0.631071	0.064642	0	0.0400	881629	OTT	F		
CP0127C	3	0.402708	0.037923	-1	0.1968	881701	OTT	F	38	RECTOSIGMOID
CP0130C	2	0.509050	0.046053	0	0.1443	881711	OTT	F	60	OVARY
CP0131C	3	0.474327	0.093535	1	0.2672	881724	OTT	F	48	BREAST
CP0134C	3	0.601266	0.053144	1	0.0319	881687	OTT	M	66	TONGUE
CP0140C	2	0.421044	0.084708	1	0.4831	881700	OTT	M	65	PROSTATE
CP0141C	3	0.467310	0.094342	0	0.2876	881254	OTT	F	65	BLADDER
CP0144C	3	0.257547	0.037589	0	0.1763	881698	OTT	F	70	BREAST
CP0145C	2	0.343872	0.054906	0	0.8642	890009	OTT	F	60	BREAST
CP0146C	2	0.235637	0.118960	0	0.5464	670699	OTT	F	58	MELANOMA
CP0147C	2	0.415308	0.058916	-1	0.3863	890006	OTT	M	72	BCC NOSE
CP0148C	2	0.506771	0.072894	-1	0.2450	890007	OTT	F	75	BCC NOSE
CP0149C	2	0.361986	0.071303	-1	0.7397	890017	OTT	F	57	MELANOMA
CP0150C	2	0.359342	0.057269	-1	0.7104	890018	OTT	F	53	BREAST
CP0151C	2	0.557401	0.090882	-1	0.2397	890005	OTT	M	63	BCC SKIN
CP0152C	3	0.433053	0.075563	-1	0.3128	890035	OTT	F	78	BREAST
CP0153C	2	0.421901	0.108350	-1	0.5409	890046	OTT	M	69	COLON
CP0154C	2	0.386558	0.047122	-1	0.4480	890030	OTT	F	67	BREAST
CP0156C	2	0.435114	0.094198	-1	0.4703	890024	OTT	F	58	COLON
CP0157C	2	0.535455	0.051610	-1	0.1439	890055	OTT	M	67	PROSTATE
CP0159C	3	0.368318	0.064282	-1	0.6334	890031	OTT	F	70	BREAST
CP0163C	1	0.306240	0.181290	-2	0.0000	890037	OTT	F	50	BREAST
CP0164C	2	0.362715	0.058727	-1	0.6860	890039	OTT	F	61	BREAST
CP0165C	2	0.527671	0.090312	-1	0.2713	890054	OTT	F	44	BREAST
CP0166C	2	0.298846	0.044300	0	0.5766	890058	OTT	F	58	BREAST
CP0167C	2	0.266741	0.084749	-1	0.5637	890060	OTT	F	73	ESOPHAGUS
CP0168C	2	0.391353	0.090597	-1	0.6169	890061	OTT	M	38	PANCREAS
CP0169C	2	0.059015	0.068458	-1	0.1478	890049	OTT	F	51	LUNG
CP0170C	2	0.394616	0.064216	-1	0.4908	890072	OTT	F	59	BREAST
CP0171C	2	0.296577	0.078255	0	0.7169	890075	OTT	F	59	LUNG
CP0172C	2	0.274811	0.084799	-1	0.6053	890084	OTT	M	47	RECTUM
CP0173C	2	0.483501	0.086166	-1	0.3256	890023	OTT	F	37	SQU C CHEEK
CP0174C	2	0.347118	0.065947	-1	0.8546	890059	OTT	M	47	BCC EYELID
CP0175C	2	0.511805	0.120430	-1	0.3744	890082	OTT	M	70	COLON
CP0176C	2	0.528463	0.058097	-1	0.1717	890096	OTT	F	71	COLON
CP0177C	2	0.404792	0.063954	0	0.4561	890101	OTT	F	37	COLON
CP0184C	2	0.201524	0.030901	-1	0.1120	890114	OTT	M	79	BCC SCALP
CP0185C	2	0.276157	0.068024	-1	0.5440	890159	OTT	F	62	BREAST
CP0186C	2	0.475659	0.072746	-1	0.2927	890130	OTT	M	58	COLON
CP0187C	2	0.378909	0.060468	-1	0.5670	890112	OTT	M	75	COLON
CP0188C	2	0.301154	0.063547	-1	0.7001	890156	OTT	F	65	BREAST
CP0189C	2	0.378686	0.082341	-1	0.6603	890151	OTT	F	73	BREAST
CP0190C	2	0.362779	0.111960	-1	0.8233	890131	OTT	F	61	BREAST
CP0191C	2	0.405239	0.072893	0	0.4798	890174	OTT	F	60	RECTUM
CP0192C	2	0.248989	0.070977	-1	0.4457	890178	OTT	M		STOMACH
CP0195C	2	0.424166	0.076547	-1	0.4390	890155	OTT	M	66	RECTUM
CP0196C	1	0.497833	0.170040	-2	0.0000	890183	OTT	F	74	BREAST

CP0197C	2	0.347333	0.078941	-1	0.8756	890175	OTT	M	45	LUNG
CP0198C	2	0.553620	0.101300	-1	0.2698	890153	OTT	M	67	PROSTATE
CP0199C	2	0.267127	0.054778	-1	0.4392	890193	OTT	M	58	PROSTATE
CP0200C	2	0.214348	0.108640	0	0.4725	890163	OTT	F	50	BREAST
CP0201C	2	0.240047	0.066491	-1	0.3924	890160	OTT	F	47	RECTUM
CP0203C	2	0.159591	0.095534	-1	0.3182	890221	OTT	M	60	MOUTH
CP0204C	2	0.314732	0.092878	-1	0.8762	890248	OTT	M	69	LARYNX
CP0205C	2	0.377869	0.036737	-1	0.4194	890207	OTT	F	44	BREAST
CP0206C	2	0.501483	0.104250	-1	0.3489	890186	OTT	F	81	LYMPHOMA
CP0207C	2	0.269352	0.126020	-1	0.6918	890225	OTT	F	65	LARYNX
CP0208C	1	0.116731	0.490830	-2	0.0000	410072	OTT	F	74	BREAST
CP0209C	2	0.280142	0.195870	-1	0.8263	890093	OTT	F	47	BREAST
CP0210C	2	0.488143	0.060007	-1	0.2236	890190	OTT	F	52	BREAST
CP0211C	2	0.276776	0.071174	0	0.5620	890209	OTT	F	54	BREAST
CP0213C	2	0.231281	0.147980	0	0.6012	890208	OTT	F	68	BREAST
CP0214C	2	0.284391	0.126650	0	0.7594	890254	OTT	F	55	BREAST
CP0215C	2	0.236428	0.120100	-1	0.5521	890234	OTT	M	66	MET CA
CP0216C	2	0.364811	0.099858	-1	0.7911	890235	OTT	M	58	TONGUE
CP0217C	2	0.397421	0.120540	0	0.6705	890240	OTT	M	55	BRAIN
CP0218C	2	0.268990	0.162620	-1	0.7525	890255	OTT	F	74	RECTUM
CP0219C	2	0.420332	0.136610	0	0.6189	890230	OTT	M	71	SALIVARY GL
CP0220C	2	0.534449	0.121990	-1	0.3437	890210	OTT	M	70	LYMPHOMA
CP0221C	2	0.338331	0.188900	0	0.9787	890253	OTT	M	72	LUNG
CP0223C	2	0.511355	0.052091	0	0.1660	890245	OTT	F	48	BREAST
CP0224C	2	0.353621	0.051227	0	0.7423	890200	OTT	F	39	BREAST
CP0226C	2	0.447125	0.133660	-1	0.5279	890162	OTT	F	24	SARCOMA
CP0227C	2	0.370058	0.041428	-1	0.5149	890262	OTT	F	43	BREAST
CP0228C	2	0.329535	0.076671	0	0.9763	890238	OTT	M	62	LUNG
CP0229C	2	0.277250	0.273280	-1	0.8672	890276	OTT	M	44	GLIOBLASTOMA
CP0230C	2	0.398046	0.182550	-1	0.7693	890273	OTT	F	30	BREAST
CP0231C	2	0.498586	0.194310	1	0.5285	890247	OTT	M	68	PROSTATE
CP0236C	2	0.447356	0.045532	-1	0.2227	890302	OTT	M	77	LIVER
CP0237C	2	0.385815	0.056336	-1	0.4987	890330	OTT	F	54	BREAST
CP0240C	2	0.420947	0.034947	-1	0.2114	881162	OTT	F	66	
CP0241C	2	0.258239	0.036259	0	0.2668	890318	OTT	M	49	RECTUM
CP0242C	2	0.433612	0.029855	-1	0.1442	890322	OTT	M	50	BCC SKIN
CP0243C	2	0.410356	0.103440	-1	0.5706	890332	OTT	F	64	BREAST
CP0244C	3	0.246820	0.114800	-1	0.5344	890334	OTT	M	60	SKIN
CP0245C	2	0.671802	0.130560	-1	0.2314	890242	OTT	M	67	PROSTATE
CP0248C	2	0.308780	0.067590	-1	0.7796	890337	OTT	F	58	BREAST
CP0249C	2	0.466642	0.099100	0	0.4023	890317	OTT	F	40	BREAST
CP0250C	2	0.307991	0.051554	-1	0.7120	890375	OTT	M	40	BRAIN
CP0251C	2	0.508847	0.117960	-1	0.3731	890361	OTT	M	54	LUNG
CP0255C	2	0.506796	0.182430	1	0.4920	890395	OTT	F	37	COLON
CP0256C	2	0.440841	0.219130	-1	0.6930	890384	OTT	F	59	BREAST
CP0259C	2	0.306564	0.093825	-1	0.8226	890440	OTT	M	70	LARYNX
CP0260C	2	0.350446	0.039696	-1	0.7224	890424	OTT	F	31	HODGKINS
CP0261C	2	0.535722	0.062761	-1	0.1805	890408	OTT	F	53	BREAST
CP0262C	2	0.205688	0.103220	1	0.4336	890419	OTT	F	56	SFT PALATE
CP0264C	2	0.321014	0.101560	-1	0.9266	890427	OTT	M	59	ORAL
CP0265C	2	0.420263	0.103790	-1	0.5331	890310	OTT	F	75	NECK
CP0267C	2	0.433758	0.088242	-1	0.4534	890394	OTT	M	60	PROSTATE
CP0269C	2	0.371582	0.133750	0	0.8097	890417	OTT	M	69	SKIN
CP0270C	2	0.338044	0.117100	-1	0.9674	890428	OTT	F	57	BREAST
CP0272C	2	0.572351	0.114660	-1	0.2810	890425	OTT	M	62	COLON
CP0273C	2	0.529341	0.130670	-1	0.3712	890432	OTT	F	59	BREAST

CP0274C	2	0.456551	0.109740	-1	0.4591	890431	OTT	F	61	BREAST
CP0275C	2	0.469908	0.095485	-1	0.3834	890499	OTT	M	36	TONSIL
CP0276C	2	0.444236	0.102800	-1	0.4714	890507	OTT	F	35	BREAST
CP0277C	2	0.513521	0.054936	-1	0.1745	890534	OTT	M	69	RECTUM
CP0278C	2	0.532961	0.072827	-1	0.2144	890497	OTT	M	57	LARYNX
CP0280C	2	0.434461	0.063711	-1	0.3483	890533	OTT	F	45	BREAST
CP0281C	2	0.421382	0.133380	0	0.6081	890479	OTT	F	57	BRAIN
CP0282C	2	0.241170	0.036328	0	0.2158	890542	OTT	F	47	BREAST
CP0283C	2	0.303295	0.042366	-1	0.6082	890551	OTT	F	69	BREAST
CP0284C	2	0.479963	0.068306	-1	0.2684	890550	OTT	F	49	BREAST
CP0285C	2	0.183467	0.035195	1	0.1191	890576	OTT	F	57	BREAST
CP0286C	2	0.267028	0.056622	-1	0.4497	890600	OTT	F	60	BREAST
CP0287C	2	0.418677	0.057031	-1	0.3637	890521	OTT	M	78	PROSTATE?
CP0288C	2	0.415710	0.048282	-1	0.3219	890516	OTT	M	56	LARYNX
CP0289C	2	0.274095	0.062429	1	0.5044	890609	OTT	F	53	THROAT
CP0290C	2	0.395411	0.160740	1	0.7505	890624	OTT	F	57	MANDIBLE
CP0291C	2	0.323680	0.024741	-1	0.7902	890643	OTT	M	58	LARYNX
CP0292C	2	0.224913	0.026163	-1	0.1054	890618	OTT	F	72	BREAST
CP0293C	2	0.400953	0.056475	-1	0.4324	890604	OTT	F	73	BREAST
CP0295C	2	0.355201	0.043614	-1	0.6852	890621	OTT	M	31	PAROTID
CP0297C	2	0.377853	0.090759	-1	0.6916	890639	OTT	M	53	RECTUM
CP0298C	2	0.444874	0.085797	-1	0.4116	890644	OTT	M	56	OROPHARYNX
CP0300C	2	0.411100	0.084761	1	0.5035	890651	OTT	M	64	BREAST
CP0304C	2	0.402722	0.123790	-1	0.6559	890596	OTT	F	64	BCC NOSE
CP0305C	2	0.306743	0.071671	-1	0.7742	890623	OTT	F	55	MAL MELANOMA
CP0307C	2	0.528089	0.082941	-1	0.2497	890694	OTT	M	67	LARYNX TONSIL
CP0308C	2	0.328652	0.125390	0	0.9807	890192	OTT	F	69	NOSTRIL
CP0309C	1	0.452320	0.108140	-2	0.0000	890677	OTT	F	55	LARYNX
CP0311C	2	0.577179	0.137330	-1	0.3237	890682	OTT	F	52	RECTUM
CP0313C	2	0.545329	0.096853	-1	0.2678	890724	OTT	F	67	MOUTH
CP0314C	2	0.470940	0.115530	-1	0.4408	890704	OTT	M	64	LUNG
CP0315C	2	0.298775	0.023270	-1	0.3563	890715	OTT	F	66	BREAST
CP0316C	2	0.526634	0.116190	-1	0.3409	890723	OTT	F	54	BREAST
CP0317C	2	0.462655	0.034477	-1	0.1345	890728	OTT	F	66	BREAST
CP0318C	2	0.339242	0.042741	-1	0.8960	890744	OTT	F	44	LARYNX
CP0319C	2	0.436863	0.102230	0	0.4914	890635	OTT	F	67	LUNG
CP0320C	2	0.383273	0.109470	-1	0.7104	890731	OTT	F	55	BREAST
CP0321C	2	0.407513	0.077599	-1	0.4901	890722	OTT	M	55	OESOPHAGUS
CP0329C	2	0.551737	0.110670	-1	0.2946	890772	OTT	M	59	PITUITARY
CP0335C	2	0.697479	0.130670	-1	0.2164	861252	OTT	F	62	ENDOMET UTUS

Table B-VII. Database for in vitro radiosensitivity testing, of LCL strains established from donors with ataxia-telangiectasia (A-T), by the acute-exposure growback assay.

AT POPULATION 9 STRAINS

ACUTE EXPOSURE
****

STRAIN	#	GB RATIO	DEV GBR	TYPE	PROB	AGE	SEX
GM0717A	2	0.086164	0.098915	1	0.1504	11	M
GM0719A	3	0.253433	0.084786	1	0.1067	13	F
GM1525C	3	-0.078060	0.103950	-1	0.0311	19	F
GM1526B	2	0.056008	0.045151	1	0.0565	28	F
GM2782A	3	0.292615	0.037907	-1	0.0290	5	M
GM2783	4	0.282122	0.038466	1	0.0101	8	M
GM3189	5	0.129499	0.047573	0	0.0013	7	M
GM3332	3	-0.067960	0.058509	0	0.0094	13	M
GM8436	2	0.101976	0.023300	0	0.0177	5	M

Table B-VIII. Database for in vitro radiosensitivity testing, of LCL strains established from donors with A-T, using the chronic-exposure growback assay.

AT POPULATION 9 STRAINS

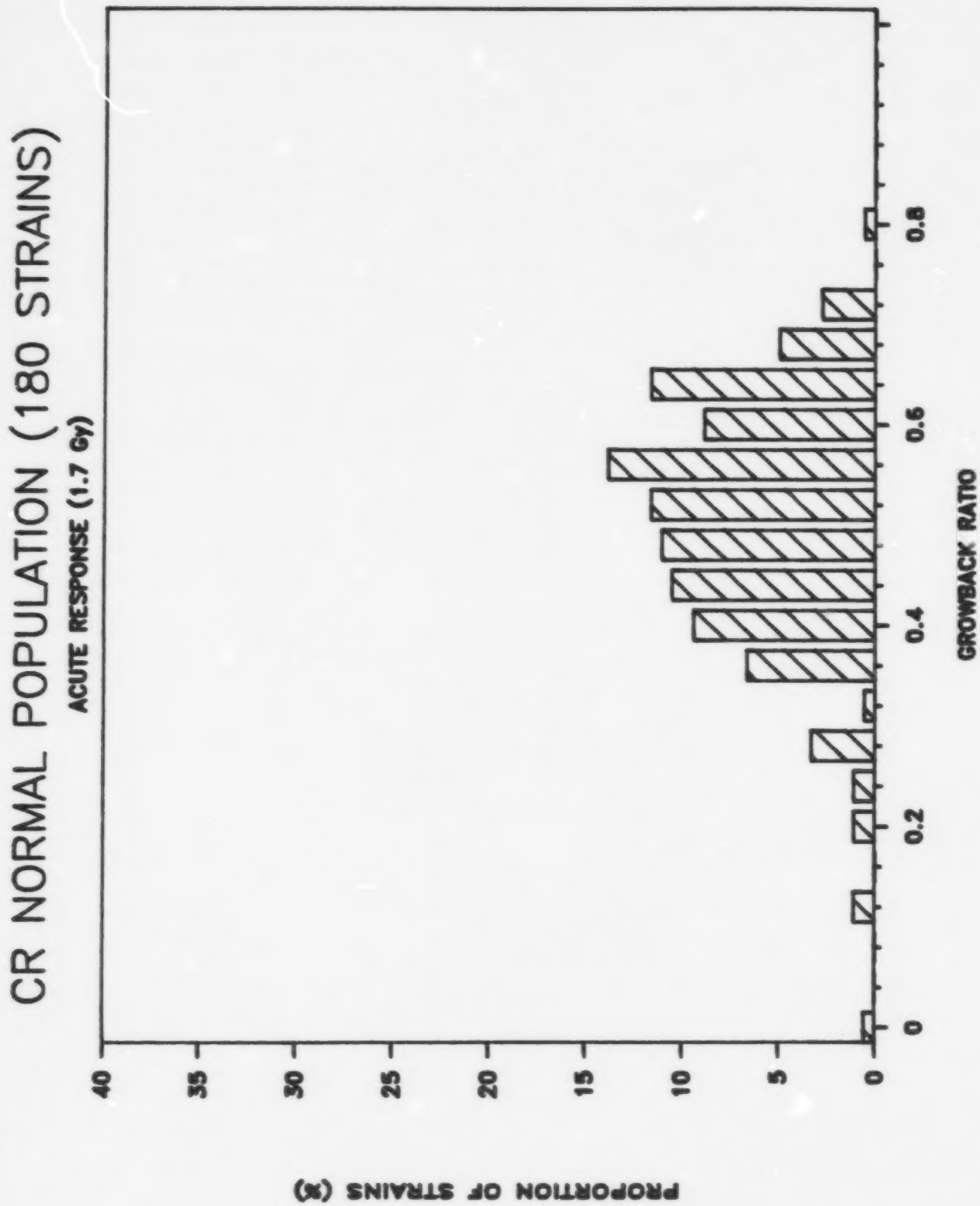
CHRONIC EXPOSURE
****

STRAIN	#	GB RATIO	DEV GBR	TYPE	PROB	AGE	SEX
GM0717A	2	-0.238634	0.138230	1	0.1491	11	M
GM0719A	3	-0.002599	0.061715	1	0.0288	13	F
GM1525C	3	-0.377195	0.048752	-1	0.0031	19	F
GM1526B	2	-0.020046	0.036617	1	0.0459	28	F
GM2782A	3	0.058792	0.093604	1	0.0977	5	M
GM2783	4	0.043482	0.059371	1	0.0147	8	M
GM3189	5	0.025506	0.048725	0	0.0025	7	M
GM3332	3	-0.156267	0.132050	1	0.0649	13	M
GM8436	2	-0.046213	0.024267	0	0.0142	5	M

Figs. B-1 to B-8.

Radioresponse distribution (% of total number of strains) in 0.04 increments of GBR (weighted means) obtained using the CRNL in vitro "growback assay". In each figure, the particular study population, the number of strains examined, and the ^{60}Co γ-ray exposure mode (acute or chronic) is indicated on the figure. Strains with negative values of GBR are grouped together in the lowest-value bar. All figures utilize the same ordinate and abscissa scales, except for the chronic exposure A-T graph, where the ordinate axis is doubled compared to the other seven.

Figure B-1


CR NORMAL POPULATION (180 STRAINS)
ACUTE RESPONSE (1.7 Gy)
PROPORTION OF STRAINS (%)
0
5
10
15
20
25
30
35
40
0
0.2
0.4
0.6
0.8
GROWBACK RATIO

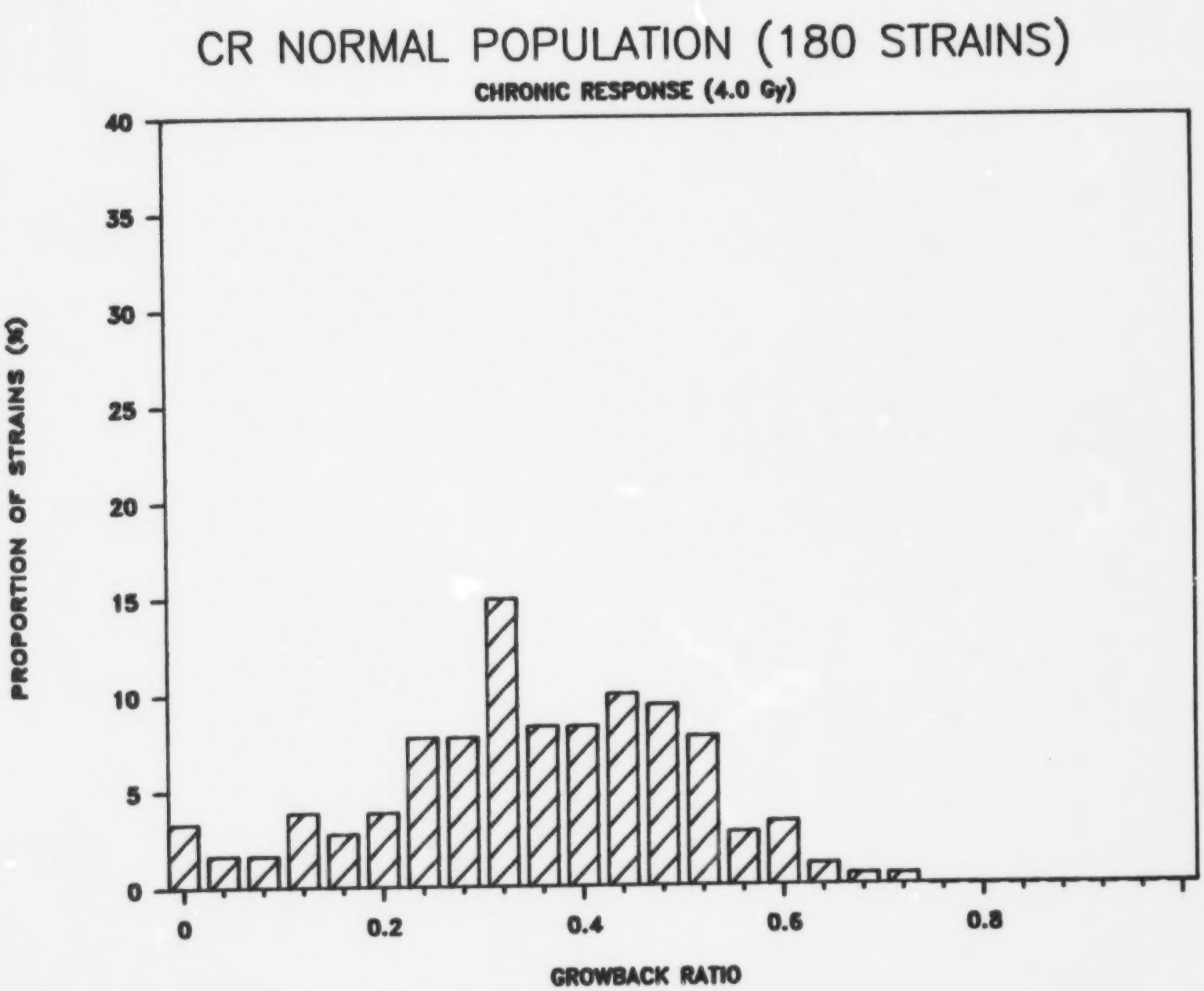

CR NORMAL POPULATION (180 STRAINS)
CHRONIC RESPONSE (4.0 Gy)
PROPORTION OF STRAINS (%)
40
35
30
25
20
15
10
5
0
0
0.2
0.4
0.6
0.8
GROWBACK RATIO

Figure B-2

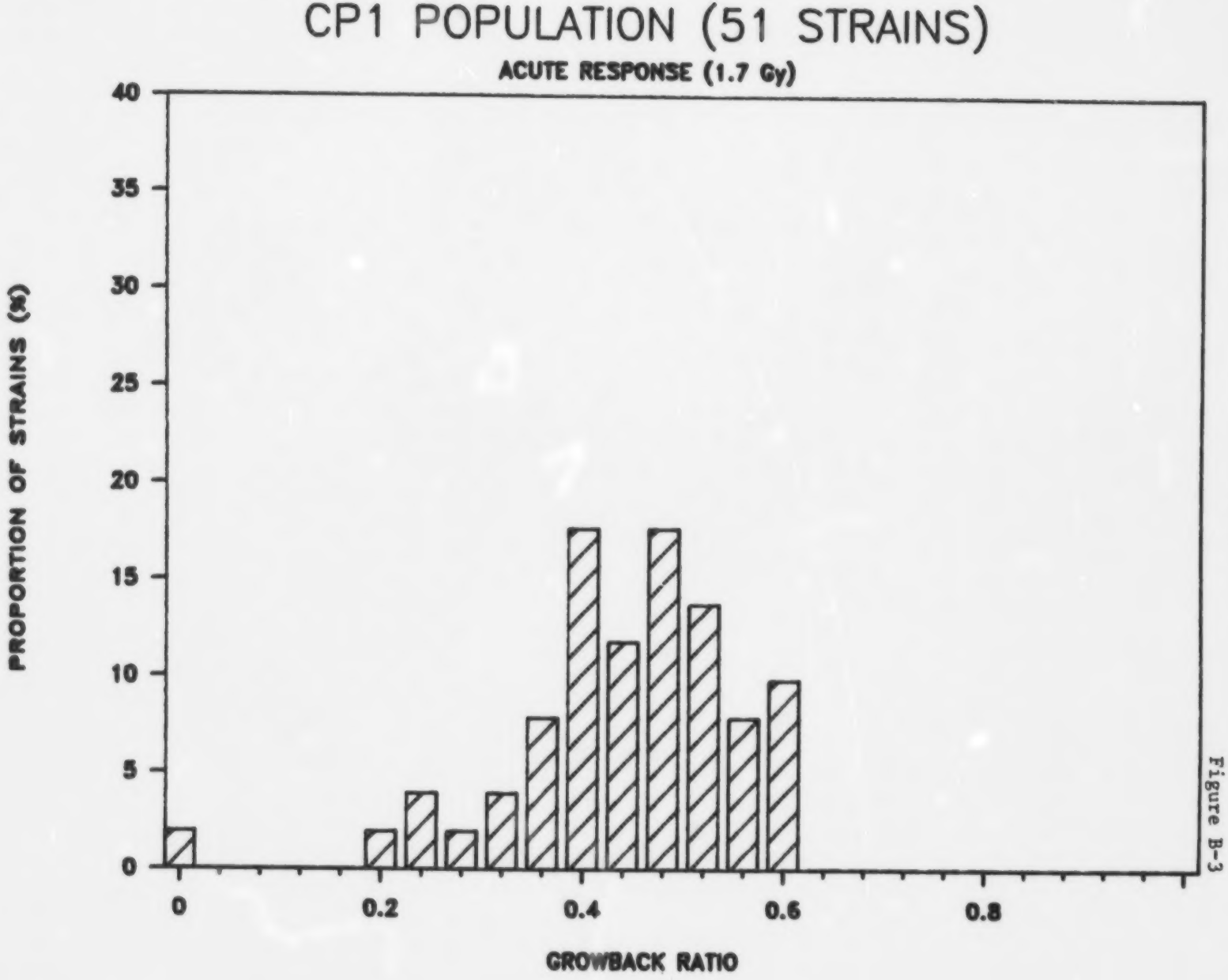

CP1 POPULATION (51 STRAINS)
ACUTE RESPONSE (1.7 Gy)
PROPORTION OF STRAINS (%)
40
35
30
25
20
15
10
5
0
0
0.2
0.4
0.6
0.8
GROWBACK RATIO

Figure B-3

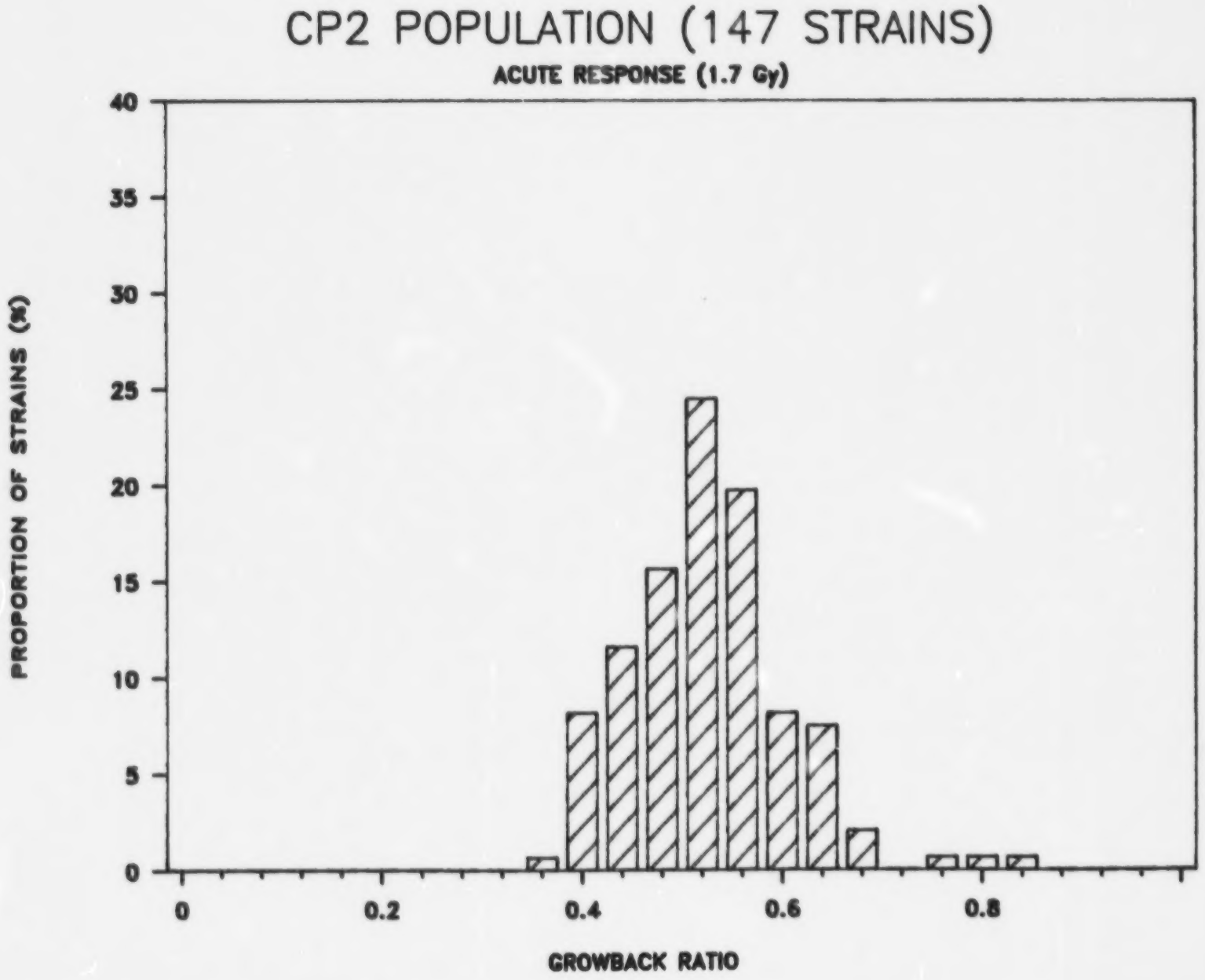

CP2 POPULATION (147 STRAINS)
ACUTE RESPONSE (1.7 Gy)
PROPORTION OF STRAINS (%)
40
35
30
25
20
15
10
5
0
0
0.2
0.4
0.6
0.8
GROWBACK RATIO

Figure B-4

Figure B-5

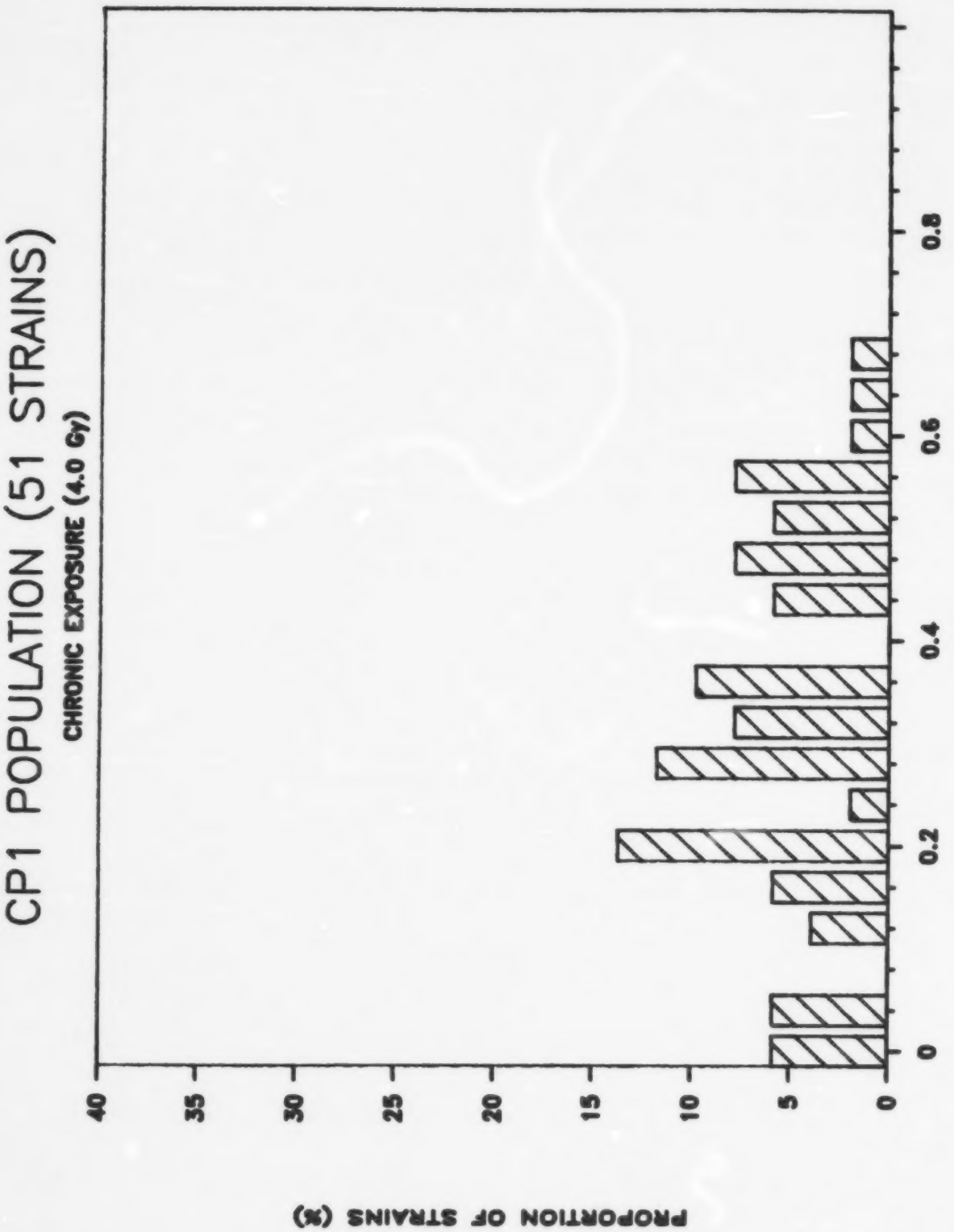

CP1 POPULATION (51 STRAINS)
CHRONIC EXPOSURE (4.0 Gy)
PROPORTION OF STRAINS (%)
40
35
30
25
20
15
10
5
0
0
0.2
0.4
0.6
0.8
GROWBACK RATIO

Figure B-6

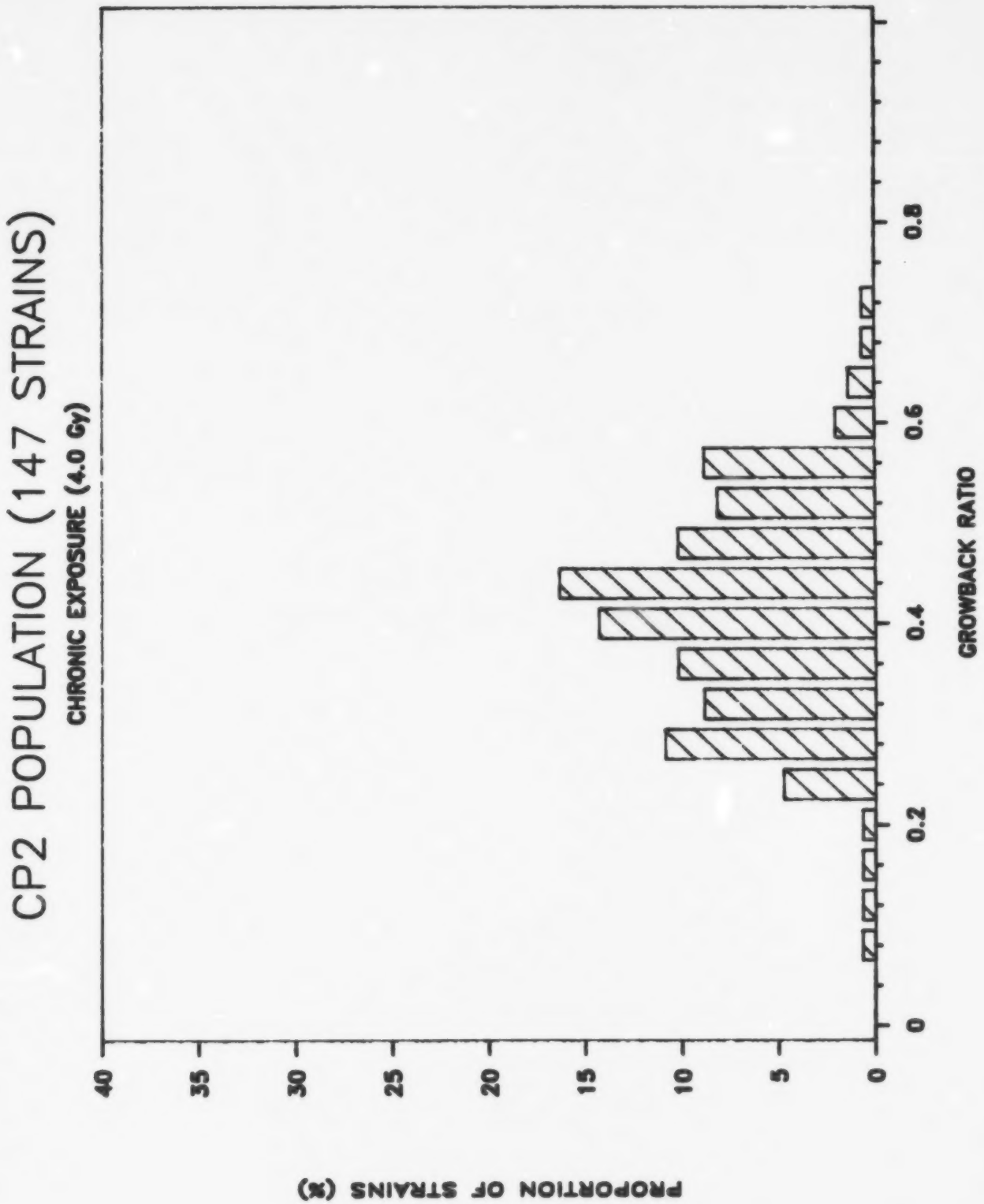

CP2 POPULATION (147 STRAINS)
CHRONIC EXPOSURE (4.0 Gy)
PROPORTION OF STRAINS (%)
40
35
30
25
20
15
10
5
0
0
0.2
0.4
0.6
0.8
GROWBACK RATIO

Figure B-7

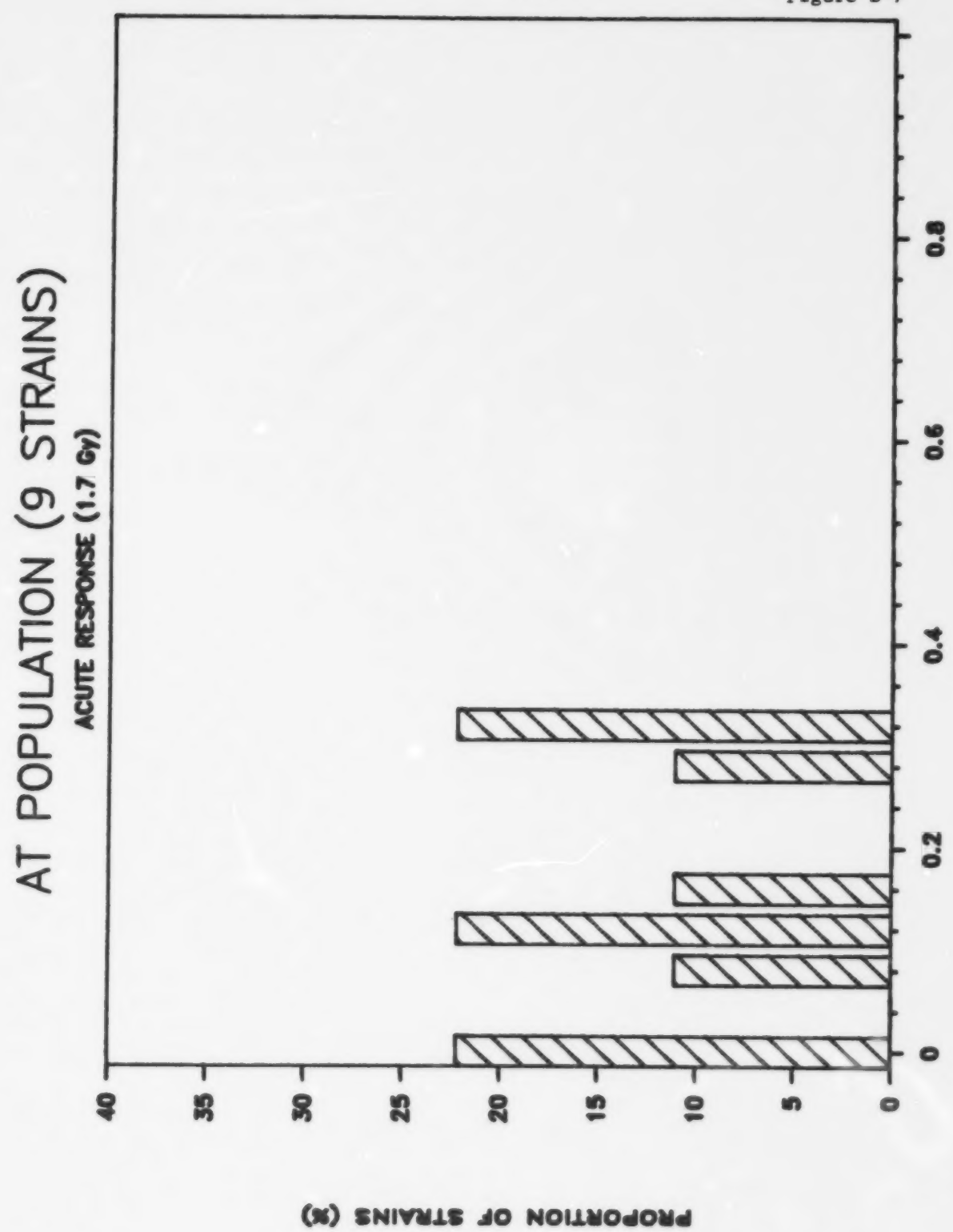
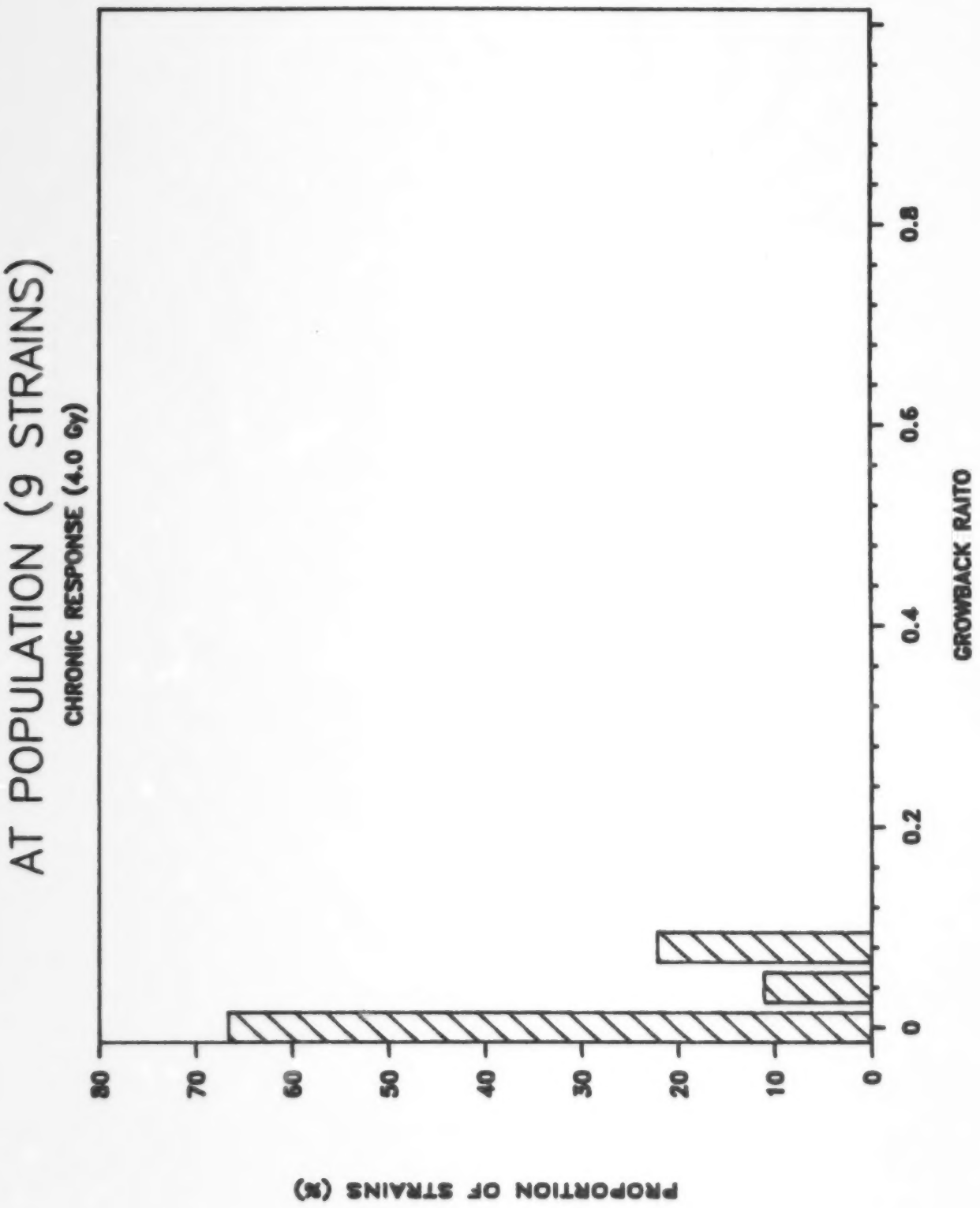

AT POPULATION (9 STRAINS)
ACUTE RESPONSE (1.7 Gy)
PROPORTION OF STRAINS (%)
40
35
30
25
20
15
10
5
0
0
0.2
0.4
0.6
0.8
GROWBACK RATIO

Figure B-8


AT POPULATION (9 STRAINS)
CHRONIC RESPONSE (4.0 Gy)
PROPORTION OF STRAINS (%)
80
70
60
50
40
30
20
10
0
0
0.2
0.4
0.6
0.8
GROWBACK RAITO

APPENDIX C

PUBLICATIONS AND ABSTRACTS

PUBLICATIONS AND ABSTRACTS

IMPACT OF STUDIES ON CULTURED HUMAN FIBROBLAST CELL STRAINS DISPLAYING ABNORMAL CARCINOGEN SENSITIVITY
N.E. Gentner
In: Health Sciences Division Progress Report, Topical Summary; (PH-HS-19), pp.1-7; AECL-8848; 1985 June

IMPACT ON RADIOGENIC CANCER RISK OF PERSONS EXHIBITING ABNORMAL SENSITIVITY TO IONIZING RADIATION
N.E. Gentner, D.P. Morrison and D.K. Myers
Twenty-fifth Hanford Life Sciences Symposium: Radiation Protection -- A Look to the Future, p.23 (1986) [Abstract]

SCREENING HUMAN POPULATIONS FOR INHERITED VARIATION IN SUSCEPTIBILITY TO ENVIRONMENTAL CARCINOGENS
N.E. Gentner and D.P. Morrison
Abstr., 30th Ann. Mtg. Canad. Fed. Biol. Soc., and Vth Mtg. Pan-American Assoc. of Biochem. Soc., p.113; 1987

SCREENING HUMAN POPULATIONS FOR ABNORMAL RADIOSENSITIVITY
D.P. Morrison and N.E. Gentner
In: Proceedings of the 8th International Congress of Radiation Research (E.M. Fielden, J.F. Fowler, J.H. Hendry and D. Scott, Eds.), p.207; Taylor and Francis, London: 1987

DETECTION AND IMPACT ON CANCER CAUSATION OF PERSONS EXHIBITING ABNORMAL SENSITIVITY TO CARCINOGENS
N.E. Gentner and D.P. Morrison
In: Research Needs in Toxicology, Proceedings of a Workshop held 1987 November 3-4 at Chalk River Nuclear Laboratories (D.K. Myers and R.V. Osborne, Eds.), pp.139-159; Chalk River; AECL-9718: 1988

IMPACT ON RADIOGENIC CANCER RISK OF PERSONS EXHIBITING ABNORMAL SENSITIVITY TO IONIZING RADIATION
N.E. Gentner, D.P. Morrison and D.K. Myers
Health Physics, 55, (2), 415-425 (1988)

RESEARCH ACTIVITIES IN HEALTH SCIENCES AT CRNL -- SCREENING HUMAN POPULATIONS FOR ABNORMAL RADIOSENSITIVITY
D.P. Morrison, N.E. Gentner and A.M. Marko
Abstr. Intl. Symp. on Risk Assessment of Energy Development and Modern Technology, Kyoto, Japan 1988 April 26-27 [Abstract]

DETECTION OF INDIVIDUAL VARIATION IN RADIOSENSITIVITY IN HUMAN POPULATIONS: POSSIBLE CONSEQUENCES FOR RADIOGENIC CANCER RISK AND FOR RADIOTHERAPEUTIC TUMOUR MANAGEMENT
N.E. Gentner and D.P. Morrison
In: NRC Workshop on Water Calorimetry (C.K. Ross and N.V. Klassen, Editors), Ottawa: National Research Council of Canada, pp.135-139 (1988)

DETERMINATION OF THE PROPORTION OF PERSONS IN THE POPULATION-AT-LARGE WHO MAY EXHIBIT ABNORMAL SENSITIVITY TO IONIZING RADIATION AND EXCESS RISK OF NEOPLASIA
N.E. Gentner and D.P. Morrison
Abstracts, AECL/CEC International Workshop on Methods for Detecting Differential Radiosensitivity in Humans, University of Sussex, Brighton, 1988 September 7-9, [Abstract]. Also N.E. Gentner was Chairman, Session on "Biochemical Methods"

A RAPID TEST FOR RADIATION SENSITIVITY USING PERIPHERAL BLOOD LYMPHOCYTES
T.J. Bichay, M.M. Werner, N.E. Gentner and D.P. Morrison
The 14th L.H. Gray Conference, New College, Oxford, England, 1988 September 11-15

DETERMINATION OF THE PROPORTION OF PERSONS IN THE POPULATION-AT-LARGE WHO EXHIBIT ABNORMAL SENSITIVITY TO IONIZING RADIATION
N.E. Gentner and D.P. Morrison
Abstracts, 14th L.H. Gray Conference, on Low Dose Radiation Biological Bases of Risk Assessment, New College, Oxford, session on "Radiosensitive Persons", 1988 September 12-15

DETERMINATION OF THE PROPORTION OF PERSONS IN THE POPULATION-AT-LARGE WHO EXHIBIT ABNORMAL SENSITIVITY TO IONIZING RADIATION
N.E. Gentner and D.P. Morrison
In: Low Dose Ionizing Radiation--Biological Bases of Risk Assessment (K.F. Baverstock and J.W. Stather, editors), London: Taylor and Francis, pp.253-262 (1988)

RADIOSENSITIVITY OF PHA-STIMULATED PERIPHERAL BLOOD LYMPHOCYTES ISOLATED FROM FRESH OR HELD BLOOD
T.J. Bichay, M.M. Werner, M.D. Cecil, D.P. Morrison and N.E. Gentner
Abst. of 37th Annual Mtg., Radiation Research Society, Seattle, 1989 March 19-24, p.174

CORRELATION BETWEEN HYPERSENSITIVITY IN VITRO TO IONIZING RADIATION AND ADVERSE REACTION TO RADIOTHERAPY IN CANCER PATIENTS
C.E. Danjoux, N.E. Gentner, P. Raaphorst and D.P. Morrison
Abst. of 37th Annual Mtg., Radiation Research Society, Seattle, 1989 March 19-24, p.164

LYMPHOBLASTIC RADIOSENSITIVITY IN CANCER PATIENTS
C.E. Danjoux, N.E. Gentner, P. Raaphorst and D.P. Morrison
Abst. of 37th Annual Mtg., Radiation Research Society, Seattle, 1989 March 19-24, p.164

SCREENING HUMAN POPULATIONS FOR ABNORMAL RADIOSENSITIVITY
D.P. Morrison, N.E. Gentner and A.M. Marko
In: Proceedings of the International Conference on Risk Assessment of Energy Development and Modern Technology (T. Sugahara, T. Aoyama, M. Ikebuchi and H. Yonehara, Eds.), Kyoto: Health Research Foundation, pp.97-112 (1989)

LYMPHOBLASTIC RADIOSENSITIVITY IN CANCER PATIENTS
C.E. Danjoux, N.E. Gentner, P. Raaphorst and D.P. Morrison
Abstracts of the Canadian Association of Radiation Oncology (1989)

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